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ABSTRACT

This document, ninth in a series of 11 subvolumes of a handbook prepared to providing training for educational research and development personnel, deals with the task of developing instructional materials. The document is organized according to the sequential steps involved in performing the task. Step 1, planning the size and order of learning units, involves: (a) estimating how many parts of the criterion behavior can be effectively practiced at the same time and (b) planning the order in which parts of the criterion behavior will be practiced. Step 2, preparing instructional materials procedures, involves preparing instructional materials or procedures integrating all subcriterion behaviors that make up the criterion behavior. Background information is included for both steps. (PD)

AIR-20241-9/71-RP

A Technology For Developing Instructional Materials

3 HANDBOOK

A. PLAN STUDY OF CRITERION BEHAVIORS

B. COLLECT AND ANALYZE DATA ABOUT CRITERION BEHAVIORS

C. SEQUENCE AND GROUP CRITERION BEHAVIORS

D. STATE CRITERION AND PREPARATORY OBJECTIVES

E. PLAN SIMULATION BASED ON INSTRUCTIONAL AND LOGISTICAL NEEDS

F. DEVELOP DIAGNOSTIC AND EVALUATIVE TESTS

G. FORMULATE INSTRUCTIONAL STRATEGIES

H. PLAN ACCOMMODATION OF INDIVIDUAL DIFFERENCES

I. DEVELOP INSTRUCTIONAL MATERIALS

J. EVALUATE INSTRUCTIONAL MATERIALS

X. INDEX

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VOLUMES IN THIS SERIES

1. USER'S MANUAL
2. ORIENTATION
3. HANDBOOK
   (eleven sub-volumes)
4. WORKBOOK
5. FINAL EXERCISES

FOREWORD

This is one of a series of eleven HANDBOOK sub-volumes which has been prepared to provide training for educational R&D personnel in the development of instructional materials.

The USER'S MANUAL, which accompanies the series, describes the role each volume is designed to play and the sequence recommended for its use in the training process. The user is, therefore, urged to read the instructions in the USER'S MANUAL before using this or any other separate volume.

ACKNOWLEDGMENTS

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U.S.O.E. sponsorship does not in any way imply official endorsement of the views expressed in this volume.

The author is indebted: to Dr. Robert Fitzpatrick for reviewing portions of the series of volumes and for informal discussions concerning several training issues; to Mrs. Zita Glasgow for the first and critical use of this volume; and, not least, to Miss Kathleen Gubala for her tireless preparation of the complex manuscript required by this HANDBOOK.

George L. Gropper
March 1973

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STEP I.1

I.1 Plan the size and order of learning units.

I.1.1 Estimate how many parts of the criterion behavior can be effectively practiced at the same time.

I.1.2 Plan the order in which parts of the criterion behavior will be practiced.

STEP I.1

OVERVIEW

INPUT	ACTION	OUTPUT
Evaluation of difficulty involved in learning the criterion behavior	Estimate the size of learning units and the order in which they will be used	Plans for sequencing practice of portions of criterion behavior

	INPUT	ACTION	OUTPUT
I.1.1	Results of: -Learning analysis on set of A.5(4) or (11) forms -Competency analysis on set of A.5(4) or (11) forms -Summary of above on FORM G.1(1) i	Review and estimate how much of the criterion behavior the learner has to practice separately ii	DECISION and PLAN -What will be practiced separately -What will be practiced in combination with other parts of criterion behavior iii
I.1.2	Decision made about how much to be practiced at the same time + prior sequencing decisions in TASK G iv	Decide on the order in which parts of the criterion behavior will be practiced v	DECISION about the order in which: -Component skills will be practiced: ··Relative to one another ··Relative to a whole Sub-STEP -A series of Sub-STEPS will be practiced vi

STEP I.1

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FOR ENTIRE STEP I.1

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I.1

IDENTIFICATION MATRIX

DIFFERENCES BETWEEN SEQUENCING DECISIONS MADE IN TASK "C" AND THOSE MADE IN STEP "I.1"

WHERE DECISIONS ARE MADE	Sequencing decisions made in TASK C	Sequencing decisions made in STEP I.1
CRITERIA	*Decisions are made about the sequence in which:* *-Separate criterion behaviors will be practiced*	*Decisions are made about the sequence in which:* *-Sub-STEPS within EACH criterion behavior will be practiced* *AND* *-Skills concerning the following components within EACH sub-STEP will be practiced:* *••INPUTS* *••ACTIONS* *••OUTPUTS*
EXAMPLES	e.g., sequencing three criterion behaviors to be practiced *-There are three criterion behaviors, one concerning each of the three classes of levers* *-A sequencing decision made in TASK C concerns the order in which to schedule practice concerning each of the three different classes of levers*	e.g., sequencing skills involving components with one criterion behavior *-There is one criterion behavior involving one class of levers* *-Two types of sequencing decisions have to be made:* *••In what order should the sub-STEPS making up the chain that is involved in the criterion behavior be practiced* *••For each sub-STEP within the chain, in what order should practice of discriminations and generalizations regarding OUTPUTS and regarding INPUTS be made; and where in the sequence should associations between INPUTS and ACTIONS be made*

I.1

IDENTIFICATION MATRIX

DIFFERENCES BETWEEN SCOPE OF DECISIONS MADE IN TASK "G" AND IN TASK "I"

WHERE DECISIONS ARE MADE	Scope of decisions made IN TASK G	Scope of decisions made IN TASK I
CRITERIA →	*-A strategy decision concerning the practice progression to be used is made concerning:* *••The predominant learning problems involved in the entire chain that makes up the criterion behavior*	*-Sequencing decisions* *AND* *-Decisions about needed instructional materials are made:* *••For EACH sub-STEP in the chain; i.e., each sub-STEP has to be practiced (and learned)* *-Decisions about this type of practice are made within the framework decided on in TASK "G"*
EXAMPLES	e.g., criterion behavior consists of a chain containing 14 sub-STEPS In TASK "G": -The predominant learning problem(s) have been identified -Progression(s) have been selected and designed to deal with this predominant problem	e.g., how to deal with sub-STEP #8 in the chain Here in TASK "I": -Each sub-STEP in the total chain has to be practiced -Ways of dealing with the learning problems involved in each sub-STEP have to be dealt with--e.g., have to deal with #8, #9, #10, etc. -The methods selected should fit in with the general strategies selected

PREVIEW OF THE NEXT SubSTEP

YOUR PRODUCT	*A plan describing how much of the criterion behavior will be practiced at the same time: ranging from a single component skill (the smallest possible amount) to the entire criterion behavior (the largest possible amount).*
WHAT YOU WILL WORK FROM	(1) Results of analyses conducted in earlier TASKS: ... learning analyses ... competency analyses
WHAT YOU WILL DO	(1) Review the results of analyses (2) Estimate which parts of the criterion behavior must be practiced separately and which parts can be practiced together in order for learning to be both effective and efficient.
FORMS YOU WILL USE	None

DESCRIPTION OF Sub-STEP	I.1.1

INPUT	ACTION	OUTPUT
Results of: -Learning analysis on set of A.5(4) or (11) forms -Competency analysis on set of A.5(4) or (11) forms -Summary of above on FORM G.1(1) i	Review and estimate how much of the criterion behavior the learner has to practice separately ii	DECISION and PLAN -What will be practiced separately -What will be practiced in combination with other parts of criterion behavior iii

Job Aid Contents

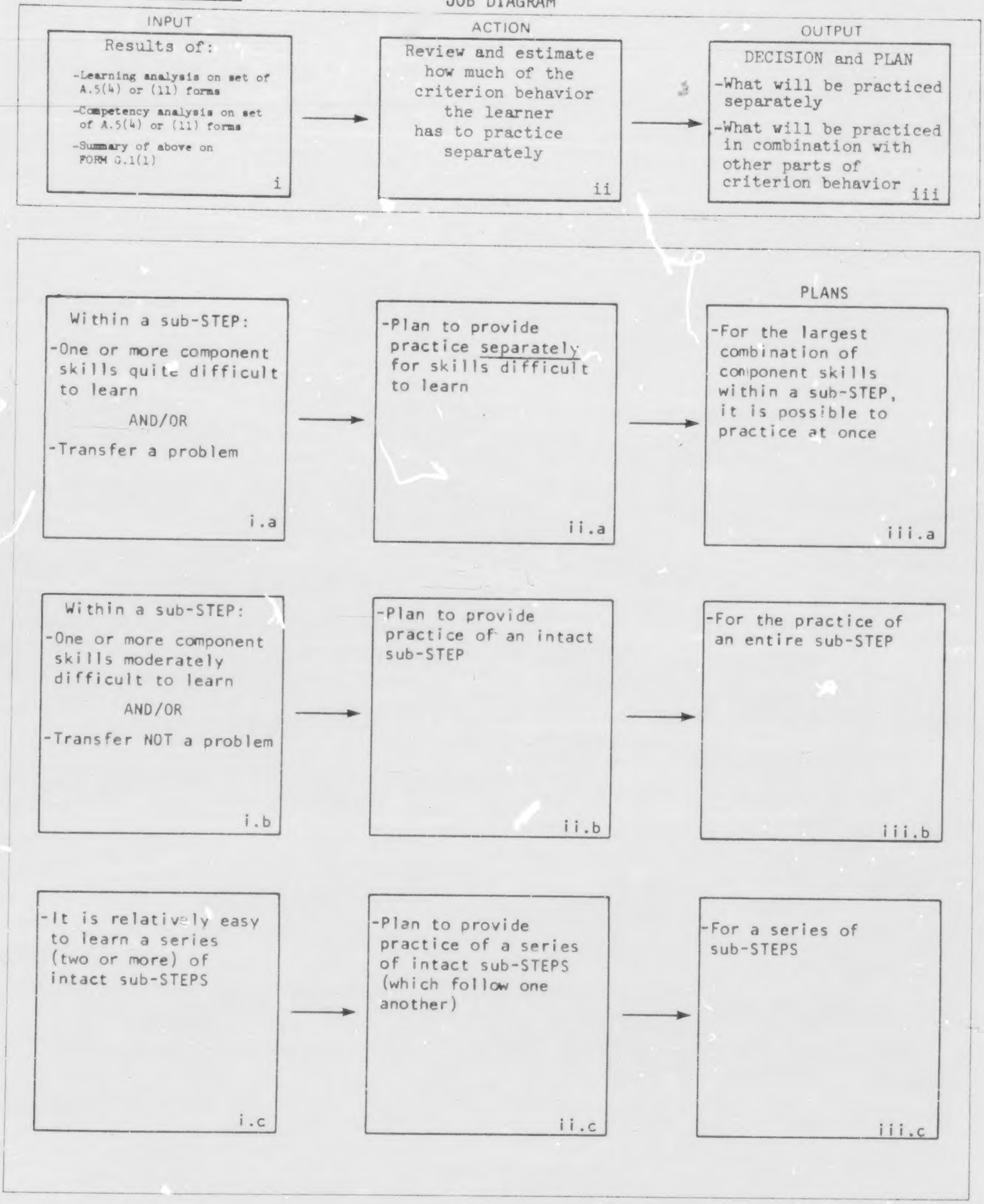
CRITERIA FOR IDENTIFYING INPUTS	ACTION TO BE TAKEN	STANDARD FOR OUTPUTS	FORMS TO USE
-MATRIX: Practice at the same time involving different amounts of criterion behavior . . . 11-18 -MATRIX: Information to review to determine size of learning unit 20	-MATRIX: Determining how much can be practiced at the same time . . . 21	-MATRIX: Adequacy of estimates of size of practice units 23	SUMMARY OF PROCEDURES . . . 22

Required Materials

COMPLETED MATERIALS	STEP	COMPLETED FORMS	STEP	BLANK FORMS
		Set of FORMS A.5(4) or (11) and G.1(1) (carried forward from)	H.2.2	

Sub-**STEP** I.1.1

JOB DIAGRAM



INPUT	ACTION	OUTPUT
Results of: -Learning analysis on set of A.5(4) or (11) forms -Competency analysis on set of A.5(4) or (11) forms -Summary of above on FORM G.1(1) i	Review and estimate how much of the criterion behavior the learner has to practice separately ii	DECISION and PLAN -What will be practiced separately -What will be practiced in combination with other parts of criterion behavior iii

		PLANS
Within a sub-STEP: -One or more component skills quite difficult to learn AND/OR -Transfer a problem i.a	-Plan to provide practice separately for skills difficult to learn ii.a	-For the largest combination of component skills within a sub-STEP, it is possible to practice at once iii.a
Within a sub-STEP: -One or more component skills moderately difficult to learn AND/OR -Transfer NOT a problem i.b	-Plan to provide practice of an intact sub-STEP ii.b	-For the practice of an entire sub-STEP iii.b
-It is relatively easy to learn a series (two or more) of intact sub-STEPS i.c	-Plan to provide practice of a series of intact sub-STEPS (which follow one another) ii.c	-For a series of sub-STEPS iii.c

BACKGROUND INFORMATION

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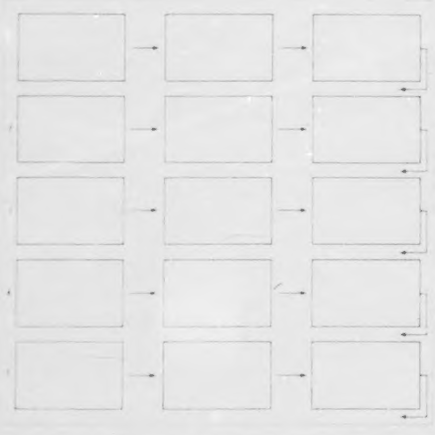
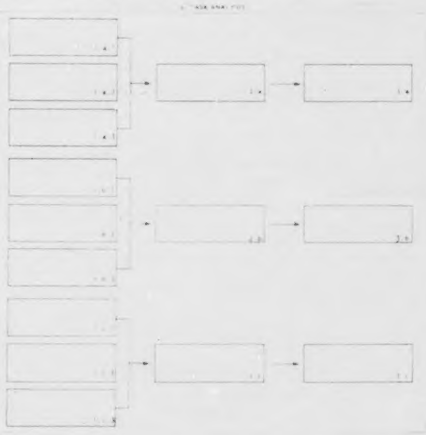
Determining when conditions permit more of criterion behavior to be practiced at the same time	18

I.1.1
IDENTIFICATION MATRIX

DECISIONS WHICH HAVE TO BE MADE ABOUT HOW MUCH SHOULD BE PRACTICED AT THE SAME TIME

TYPES OF UNIT-OF-PRACTICE DECISIONS	How much of the TOTAL CHAIN should be practiced at the same time	How many of the COMPONENT SKILLS within a sub-STEP should be practiced at the same time
CRITERIA	*-A decision has to be made about how many of the sub-STEPS in a chain can be effectively practiced at the same time* *-The possibilities are:* *••None (e.g., when the component skills within sub-STEPS are difficult and have to be treated separately, see right-hand column)* *••One or more* *••All*	*-A decision has to be made about how many of the component skills can be effectively practiced at the same time* *-The possibilities are:* *••One at a time* *••Two or more at a time* *••All at the same time* *-The component skills (discriminations, generalizations, and associations) are therefore practiced:* *••Individually* *••In combination, OR* *••Altogether*
EXAMPLES	e.g., how many of these sub-STEPS can be practiced at the same time 	e.g., how many of the component skills can be practiced at the same time 

I.1.1

EXAMPLES ILLUSTRATING WHAT "PRACTICE AT THE SAME TIME" MEANS

EXAMPLES

	Practice of the WHOLE at the same time	Practice only of PARTS at the same time
For Sub-STEPS in a CHAIN	e.g., threading a film projector *With the aid of a diagram, the learner practices the threading operation from beginning to end (i.e., the complete operation or* *all* *sub-STEPS or sub-sub-STEPS are practiced at the same time)*	e.g., threading a film projector *The learner practices the various sub-STEPS of the threading operation in isolation--away from the practice of other sub-STEPS. For example, he may practice just making a loop, or he may just practice inserting the film onto the sprockets. (Subsequently, he practices the other sub-STEPS, and, eventually, the entire operation)*
For COMPONENT SKILLS within a Sub-STEP	e.g., using present tense verbs with singular and plural nouns *-With the aid of a diagram, the learner practices using the correct form of the verb appropriate to the noun in the sentence* *-At one and the same time he is practicing discriminating between what is singular and plural, generalizing across each of these two classes, and associating the right form of the verb with each*	e.g., using present tense verbs with singular and plural nouns *-Prior to the kind of practice described at the left (in which the learner uses both the noun and a verb in his sentence), he may be required to engage in practice of component skills:* *••He may be given separate practice in discriminating between what is a singular noun and what is a plural noun (without using a verb at this time)*

I.1.1
DECISION
MATRIX

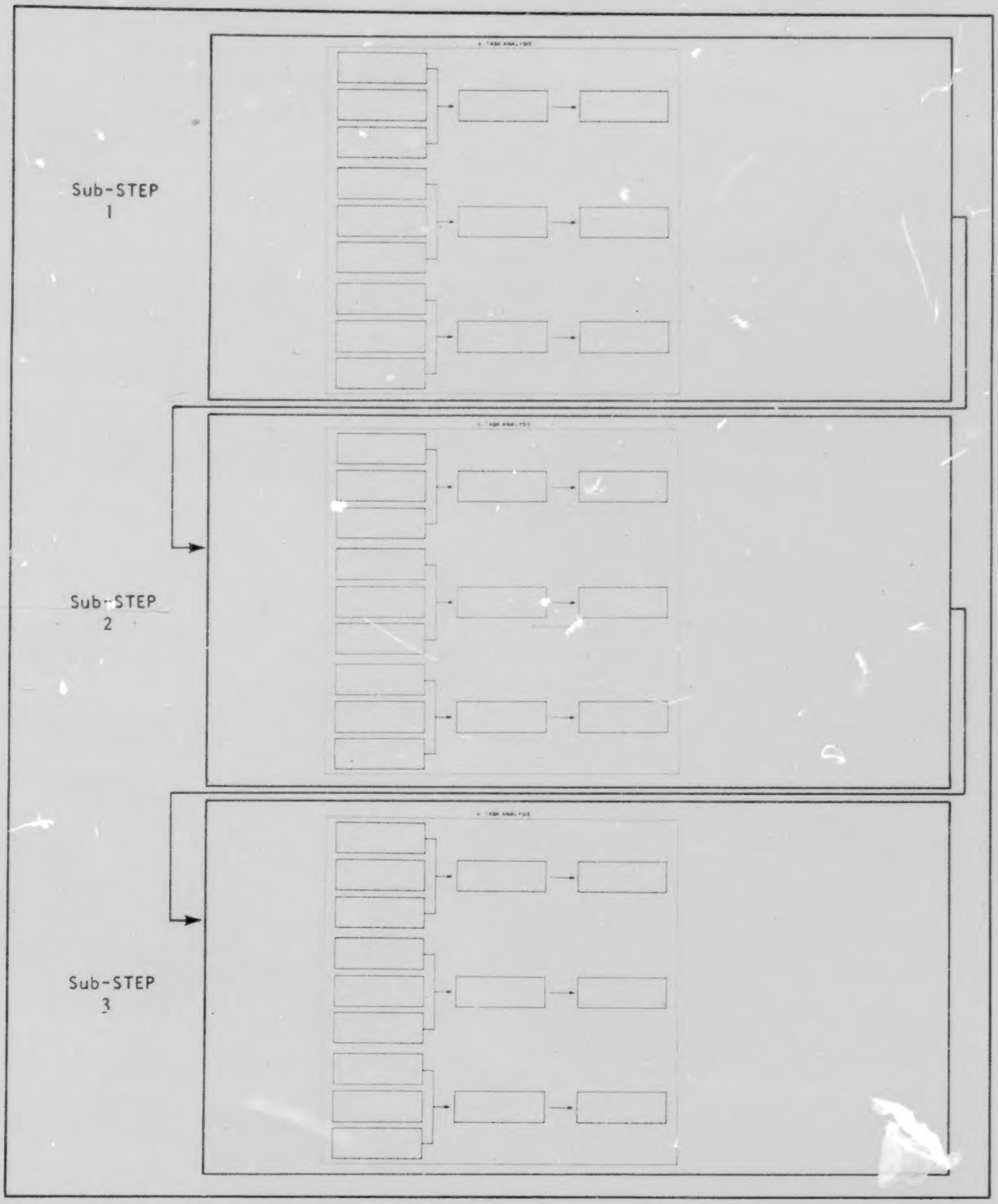
PRIORITIES WHEN DECIDING HOW MUCH SHOULD BE PRACTICED AT THE SAME TIME

PRIORITIES	FIRST (whenever possible)	SECOND	THIRD
ACTION TO TAKE	*For practice of COMPONENT SKILLS within a sub-STEP*		
	-Provide practice that deals with all the skills at the same time *-Provide assistance (when necessary) to make it possible*	*-Provide practice that deals with as many of the skills that the student can handle with assistance*	*-Provide practice that deals with skills one at a time*
	For practice of sub-STEPS within a total chain		
	-Provide practice that deals with all the sub-STEPS at the same time *-Provide assistance (when necessary) to make it possible*	*-Provide practice that deals with as many of the sub-STEPS that the student can handle with assistance*	*-Provide practice that deals with sub-STEPS one at a time*
RATIONALE	-The efficiency of learning is increased by having the student attempt as much as he is capable of at the same time		-When the component skills are difficult, they may have to be dealt with one at a time

I.1.1

EXAMPLES ILLUSTRATING VARIATIONS IN HOW MUCH MIGHT BE PRACTICED AT THE SAME TIME (ON THIS PAGE AND ON OPPOSITE PAGE)

EXAMPLES


Sub-STEP 1
Sub-STEP 2
Sub-STEP 3

I.1.1

EXAMPLES ILLUSTRATING VARIATIONS IN HOW MUCH MIGHT BE PRACTICED AT THE SAME TIME (ON THIS PAGE AND ON OPPOSITE PAGE)

EXAMPLES

COMPARISON #1	The MAXIMUM EFFICIENCY which is possible -*With the aid of a model demonstration the learner practices all three sub-STEPS (1, 2, and 3) in sequence*	The MINIMUM EFFICIENCY which is possible -*Even with aids, the learner has to practice each and every component skill separately: for Sub-STEP 1, for Sub-STEP 2, and for Sub-STEP 3*
COMPARISON #2	GREATER EFFICIENCY -*Two of the three sub-STEPS can be practiced at the same time*	LESSER EFFICIENCY -*Only one of the sub-STEPS can be practiced at the same time*
COMPARISON #3	GREATER EFFICIENCY -*One of the sub-STEPS can be practiced in its entirety*	LESSER EFFICIENCY -*Only one or two component skills within that sub-STEP can be practiced at the same time*
COMPARISON #4	GREATER EFFICIENCY -*Three of the component skills within a sub-STEP can be practiced at the same time*	LESSER EFFICIENCY -*Each of the component skills within the same sub-STEP has to be practiced separately*

I.1.1

IDENTIFICATION MATRIX

IDENTIFICATION OF CONDITIONS WHICH PERMIT MORE OF THE CRITERION BEHAVIOR TO BE PRACTICED AT THE SAME TIME

HOW MUCH CAN BE PRACTICED	A LARGER part of the criterion behavior can be practiced at the same time when:	A LESSER part of the criterion behavior can be practiced at the same time when:
CRITERIA	*-The skills involved are relatively easy to learn* *-When there is difficulty in learning the skills, assistance can be devised which still permits the practice of:* *••A number of component skills within a sub-STEP to be learned at the same time; OR* *••A number of sub-STEPS within the total chain to be learned at the same time*	*-The skills involved are relatively difficult to learn* *-When there is difficulty in learning the skills, providing assistance is insufficient to the task of creating practice of:* *••A number of component skills within a sub-STEP to be learned at the same time; OR* *••A number of sub-STEPS within the total chain to be learned at the same time*
EXAMPLES	*e.g.,* *-With the aid of a diagram, the student can practice and learn the proper sequence of steps to follow in threading a film projector; it is unnecessary to provide practice for each of the steps separately (or for the component skills within any step)*	*e.g.,* *-The student pilot is likely to require separate practice for component skills or for sub-STEPS in the landing operation*

JOB PROCEDURES

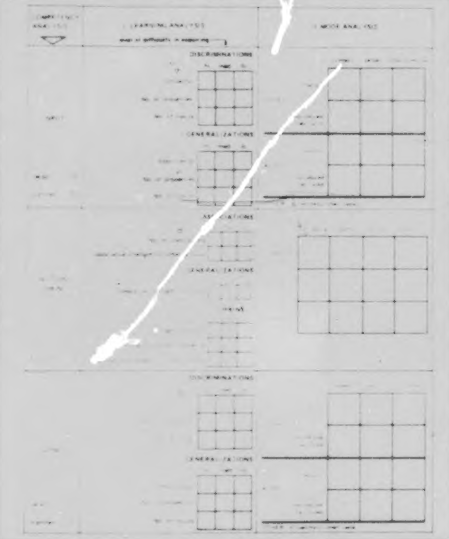
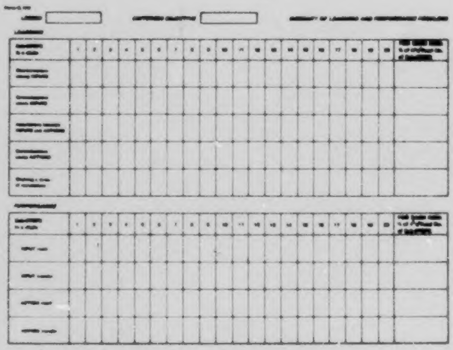
	page
Information to review to determine the ease or difficulty of what has to be learned	20
Determining how much can be practiced at the same time	21
SUMMARY OF PROCEDURES	22
Adequacy of determination of how much can be practiced at the same time	23

I.1.1

IDENTIFICATION MATRIX

THREE INFORMATION SOURCES TO REVIEW IN DETERMINING HOW MUCH OF CRITERION BEHAVIOR CAN BE PRACTICED AT THE SAME TIME AND HOW MUCH (WHAT) WILL HAVE TO BE PRACTICED SEPARATELY

	1	2	3
SOURCE OF INFORMATION	Results of LEARNING ANALYSIS on separate A.5(4) FORMS for each sub-STEP in the total chain	Results of COMPETENCY ANALYSIS (PERFORMANCE) on separate A.5(4) FORMS for each sub-STEP in the total chain	Summary of LEARNING AND PERFORMANCE analyses on FORM G.1(1) for entire chain
CRITERIA	*For EACH sub-STEP* *-The rating of the difficulty of learning each component skill in the sub-STEP by the source of the difficulty* *••High difficulty* *••Medium difficulty* *••Low difficulty*	*For EACH sub-STEP* *-Identification of the performance requirements for INPUTS and ACTIONS* *••RECALL* *••TRANSFER*	*For ALL sub-STEPS* *-Identification of those sub-STEPS in the chain with high difficulty learning problems* *-Identification of those sub-STEPS in the chain with transfer requirements*

	FORM A.5(4)	FORM G.1(1)
FORMS		

I.1.1

DECISION MATRIX

DETERMINING HOW MUCH CAN BE PRACTICED AT THE SAME TIME*

CONDITIONS	It is estimated that: -The difficulty of learning one or more component skills within a sub-STEP is quite HIGH; AND/OR -Transfer is a major problem	It is estimated that: -The difficulty of learning one or more component skills within a sub-STEP is moderately LOW; AND/OR -Transfer is NOT a major problem	It is estimated that: -The difficulty of learning a succession of intact or whole sub-STEPS is relatively LOW; AND/OR -Transfer is NOT a major problem
ACTION TO TAKE	*-Create separate practice opportunities for each of the component skills within the sub-STEP that are difficult* *-Combine practice for the remaining component skills which are not difficult* *-Provide assistance which makes it possible to combine as much as possible*	*-Create an opportunity in which the learner can practice the entire sub-STEP (thus, NOT providing separate practice for the component skills)*	*-Create an opportunity in which the learner can practice two or more sub-STEPS in sequence (thus, NOT providing separate practice for each sub-STEP)*

*Always overestimate how much can be combined; during tryout of materials (See TASK J), the overestimate can be identified and corrected. An underestimate cannot be identified. You'll never know how much the learner could have done.

EXAMPLE:* *Long division* $51\overline{)932}$	e.g., *-Assume the developer estimated that each operation in long division was sufficiently difficult to require practice of the component skills that underlie it* *-Practice might be provided:* *••Discriminating between divisors containing varying number of units (i.e., units, tens, hundreds)* PLUS *••Discriminating between the size of dividends into which divisors will and will not go, etc.*	e.g., *-Assume the developer estimated that each operation was not so difficult as to require practice of component skills (i.e., discriminations, generalizations, or associations)* *-Practice might be provided for each whole operation:* *••e.g., estimating the number of units into which the divisor will go*	e.g., *-Assume the developer estimated that a series of operations could be practiced at the same time (preceded by a demonstration)* *-Practice might be provided for two or more whole operations:* *••e.g., estimating the number of units into which the divisor will go* PLUS *••Actually dividing into the first 100's (i.e., 51 into 93)*

*The same example is used in each of the three columns; thus, it shows how the long division problem would be handled if different developers estimated the difficulty of the learning problem differently.

I.1.1

ILLUSTRATION SUMMARIZING PROCEDURES INVOLVED IN PLANNING HOW MUCH OF CRITERION BEHAVIOR CAN BE PRACTICED AT THE SAME TIME

#1

REVIEW
results of

a. LEARNING ANALYSES on the set of FORMS A.5(4) for the entire chain
b. COMPETENCY ANALYSES on the set of FORMS A.5(4) for the entire chain
c. SUMMARY of the above two analyses for all sub-STEPS on a single FORM G.1(1)

#2

IDENTIFY

a. Level of difficulty estimated for learning problems
b. Amount of transfer involved

#3

DECIDE
whether to

a. Provide practice opportunities for separate or combined component skills within a sub-STEP

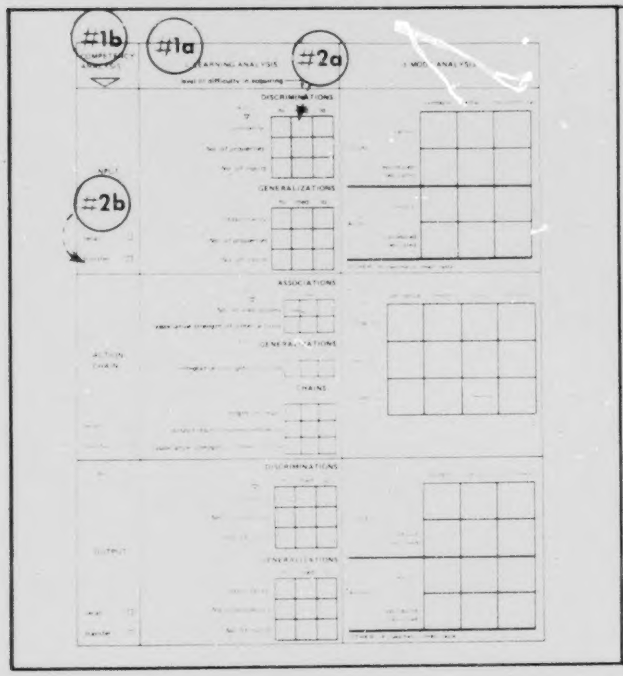
OR

b. Provide practice for a whole sub-STEP at the same time

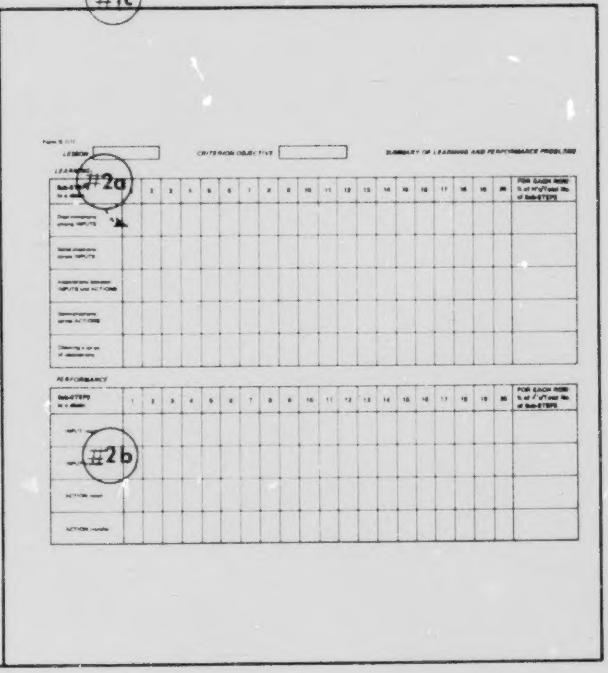
OR

c. Provide practice for two or more sub-STEPS which follow one another in sequence

FORM A.5(4)


#1b
#1a
#2a
#2b
LEARNING ANALYSIS
DISCRIMINATIONS
GENERALIZATIONS
ASSOCIATIONS
CHAINS
ACTION CHAIN
OUTPUT

FORM G.1(1)


#1c
#2a
#2b
LESSON
CRITERION OBJECTIVE
SUMMARY OF LEARNING AND PERFORMANCE PROBLEMS
PERFORMANCE

I.1.1
STANDARDS
MATRIX

CRITERIA FOR IDENTIFYING THE ADEQUACY OF ESTIMATES OF HOW MUCH CAN BE PRACTICED AT THE SAME TIME

PROPERTIES	RELEVANCE	COMPLETENESS	IMPACT ON EFFICIENCY OF INSTRUCTION
CRITERIA	*-Estimates of how much can be practiced at the same time are based on data* *··Learning analysis* *··Competency analysis* *-Estimates are based on the evaluation of the level of difficulty involved in learning parts of the criterion behavior* *··The more difficult the learning problem, the smaller the amount of the criterion behavior that can be practiced at the same time*	*-Each sub-STEP in the total chain making up the criterion behavior is:* *··Reviewed for learning difficulty, AND THEN* *··Considered for:* */Practice of its component skills* */Practice by itself in its entirety* */Practice in combination with other intact sub-STEPS*	*-Decisions of how much can be practiced are better OVERESTIMATED in the interest of efficiency* *-Consequences of overestimation are later easily overturned during tryout of instructional materials (See TASK J)*

PREVIEW OF THE NEXT SubSTEP

YOUR PRODUCT	*A decision about the order in which practice will occur for:* *... each component skill within a SubSTEP* *... each SubSTEP making up the criterion behavior*
WHAT YOU WILL WORK FROM	(1) Plans about how much of the criterion behavior will be practiced at the same time. (2) Sequencing decisions made earlier in TASK G.
WHAT YOU WILL DO	(1) Decide on the order in which the parts of the criterion behavior will be practiced.
FORMS YOU WILL USE	None

DESCRIPTION OF Sub-STEP I.1.2

INPUT	ACTION	OUTPUT
Decision made about how much to be practiced at the same time + prior sequencing decisions in TASK G iv	Decide on the order in which parts of the criterion behavior will be practiced v	DECISION about the order in which: -Component skills will be practiced: ••Relative to one another ••Relative to a whole Sub-STEP -A series of Sub-STEPS will be practiced vi

Job Aid Contents

CRITERIA FOR IDENTIFYING INPUTS	ACTION TO BE TAKEN	STANDARD FOR OUTPUTS	FORMS TO USE
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Required Materials

COMPLETED MATERIALS	STEP	COMPLETED FORMS	STEP	BLANK FORMS
Decision about scope of practice	I.1.1	Decision about order of practice	G.2.1	

Sub- **STEP** I.1.2

JOB DIAGRAM

INPUT	ACTION	OUTPUT
Decision made about how much to be practiced at the same time + prior sequencing decisions in TASK G iv	Decide on the order in which parts of the criterion behavior will be practiced v	DECISION about the order in which: -Component skills will be practiced: ••Relative to one another ••Relative to a whole Sub-STEP -A series of Sub-STEPS will be practiced vi
Component skills within a sub-TASK require separate practice iv.a	Plan order of practice of component skills v.a	Planned order of practice: -Regarding: OUTPUTS -Regarding: INPUTS -Regarding: ACTIONS -Regarding: INPUTS and ACTIONS -Regarding: Whole sub-STEPS vi.a
Component skills require practice: -In some but not all sub-STEPS in a chain iv.b	Plan order of practice of component skills and of sub-STEPS v.b	Planned order of practice: -Of component skills within a sub-STEP before practice of sub-STEP and before combination of sub-STEP with other sub-STEPS vi.b
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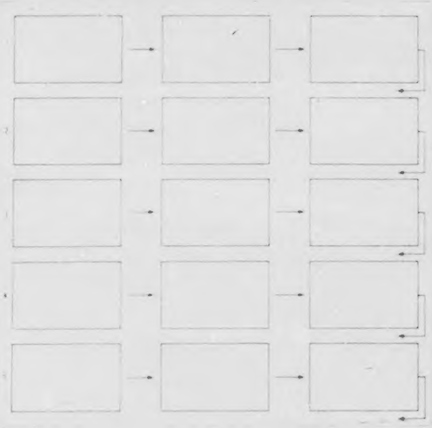
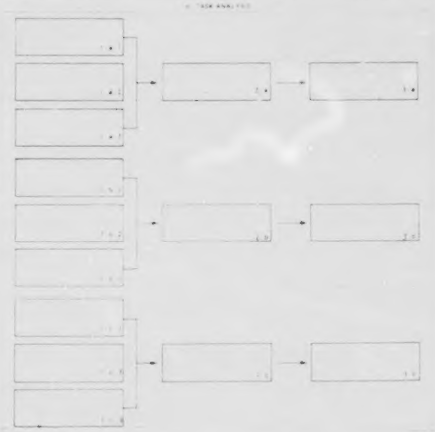
I.1.2

IDENTIFICATION MATRIX

TWO TYPES OF SEQUENCING DECISIONS WHICH HAVE TO BE MADE

TYPES OF SEQUENCING DECISIONS	Decisions about order of practice of all the separate sub-STEPS in a chain (See pages 32 and 33)	Decision about order of practice of component skills within each sub-STEP (See pages 30 and 31)
CRITERIA	*-A decision has to be made about the order in which each sub-STEP in the total chain should be practiced* *••Should practice begin with the first sub-STEP and proceed to the last sub-STEP? OR* *••Should practice begin with the last sub-STEP and work back to the first sub-STEP?*	*-A decision has to be made about the order in which the component skills within each sub-STEP should be practiced* *-In what order should the student practice:* *••Discriminating and generalizing regarding INPUTS* *••Discriminating and generalizing regarding OUTPUTS* *••Associating INPUTS and ACTIONS* *••Generalizing about ACTIONS*
EXAMPLES	e.g., in what order should sub-STEPS 1-5 be practiced 	e.g., what order should practice involve: INPUTS, ACTIONS, OUTPUTS within each Sub-STEP 

I.1.2
DECISION
MATRIX

GENERAL RECOMMENDATION OF ORDER IN WHICH STUDENTS SHOULD BE GIVEN PRACTICE IN COMPONENT SKILLS WITHIN A SINGLE SUB-STEP

(ON THIS AND OPPOSITE PAGE)

"ORDER" PRIORITIES	1 FIRST type of practice	2 SECOND type of practice
ACTION TO TAKE	Condition: When students are not already able to discriminate between or generalize across OUTPUTS -*Create practice:* ••*Discriminating between OUTPUTS* ••*Generalizing across OUTPUTS*	Condition: When students are not already able to discriminate between or generalize across INPUTS -*Create practice:* ••*Discriminating between INPUTS* ••*Generalizing across INPUTS*
RATIONALE	-Students will be able to identify: ••Correct vs. incorrect OUTPUTS ••Acceptable vs. unacceptable OUTPUTS ••Situations requiring them to: /Stop /Continue (to next sub-STEP) /Redo what they've done -The ability to make these identifications provides effective feedback when the student then goes on to practice taking ACTIONS that will produce the OUTPUT	-This type of practice precedes associating INPUTS and ACTIONS because the student cannot determine which ACTION goes with which INPUT if he cannot tell the difference between INPUTS

I.1.2

DECISION MATRIX

GENERAL RECOMMENDATION OF ORDER IN WHICH STUDENTS SHOULD BE GIVEN PRACTICE IN COMPONENT SKILLS WITHIN A SINGLE SUB-STEP

(ON THIS AND OPPOSITE PAGE)

"ORDER" PRIORITIES	3 THIRD type of practice	4 FOURTH type of practice
ACTION TO TAKE	Condition: When students are not already able to generalize across ACTIONS (and it is required) *-Create practice:* *••Generalizing across ACTIONS* *AND/OR* Condition: When students are not already able to discriminate between ACTIONS (and it is difficult to do so) *-Create practice:* *••Discriminating between ACTIONS*	Conditions: When students cannot already associate INPUTS and ACTIONS *-Create practice:* *••Associating INPUTS and ACTIONS*

RATIONALE	-This type of practice precedes associating INPUTS and ACTIONS because the student cannot determine which ACTION goes with which INPUT if he cannot tell the difference between ACTIONS or see similarities among ACTIONS	-All the elements involved in the association are now correctly learned

I.1.2
IDENTIFICATION MATRIX

TWO POSSIBLE ORDERS FOR SEQUENCING THE PRACTICE OF SUB-STEPS

SEQUENCE OF PRACTICE OF SUB-STEPS	FORWARD	BACKWARD
CRITERIA	-The learner starts practice with: ••The first sub-STEP in the chain OR ••A combination of the first sub-STEP and one or more subsequent sub-STEPS (depending on decision made in I.1.1)	-The learner starts practice with: ••The last sub-STEP in the chain OR ••A combination of the last sub-STEP and one or more prior sub-STEPS (depending on decision made in I.1.1)
EXAMPLES	e.g. the teacher learning to thread a film projector starts practice by putting the reel with film on to the projector, goes through intermediate routines and ends with attaching film leader to take-up reel.	e.g. the teacher learning to thread a film projector starts by learning to attach film leader on to a take-up reel, proceeds in a backward order through intermediate routines and ends with (what in performance is actually the first routine) putting the reel with film on to the projector.

I.1.2

DECISION MATRIX

DETERMINING WHEN TO USE EITHER A FORWARD OR BACKWARD SEQUENCE*

CONDITIONS	During TASK "G" a backward sequence HAS BEEN selected	During TASK "G" a backward sequence has NOT been selected
ACTION TO TAKE	*-Plan to implement the backward sequence for those learning or performance problems calling for them (i.e., as per recommendations on FORM G.1(2))*	*-Still consider the use of a* *backward* *order for:* *••Relatively long chains (of whatever type)--i.e., those that have many sub-STEPS* *••Chains whose primary learning problem involves remembering the* *sequence* *of sub-STEPS, i.e., "what comes next"* *-Consider a* *forward* *order:* *••For relatively short chains* *••For chains whose primary learning problems concern other component skills (i.e., discriminations or generalizations or associations within a sub-STEP)*

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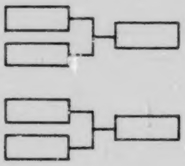
*There are no empirical data to date which unequivocally support a recommendation of a "backward" order. Although there are strong rational considerations supporting the use of backward chaining (See TASK G, page 106), its use is therefore considered optional.

I.1.2

DECISION MATRIX

DETERMINING HOW TO MAKE DUAL DECISIONS ABOUT "SCOPE" AND "ORDER" OF PRACTICE

CONDITIONS	Decision made in I.1.1 that the practice of COMPONENT SKILLS within a sub-STEP is NECESSARY	Decision made in I.1.1 that the practice of COMPONENT SKILLS within a sub-STEP is NOT necessary
ACTION TO TAKE	*-Plan for practice to begin with component skills within the sub-STEP* *ONLY THEN* *-Plan practice of an entire sub-STEP (in either forward or backward order):* *··By itself* *OR* *··In combination with other entire sub-STEPS*	*-At the start, plan for the practice of the entire sub-STEP:* *··By itself* *OR* *··In combination with other entire sub-STEPS*
EXAMPLES	e.g., Separate practice of discriminations and generalizations is necessary  *-Schedule the practice of discriminations and generalizations first* *-Then schedule practice of the entire sub-STEP*	e.g., Separate practice of discriminations and generalizations is NOT necessary *-Schedule the practice of the entire sub-STEP without any prior practice of component skills*

I.1.2

EXAMPLES ILLUSTRATING SEQUENCING PRIORITIES BASED ON A VARIETY OF PRIOR "SCOPE" DECISIONS

EXAMPLES

#1

Sub-STEP 1	Sub-STEP 2	Sub-STEP 3
Component skill practice is required	Component skill practice is required	Component skill practice is required

-If a forward order is to be used, the recommended sequence of practice is as follows:

(1) *Practice of component skills for Sub-STEP #1*

(2) *Practice of entire Sub-STEP #1*

(3) *Practice of component skills for Sub-STEP #2*

(4) *Practice of entire Sub-STEP #2*

(5) *Practice both of entire Sub-STEP #1 and entire Sub-STEP #2 (in sequence)*

(6) *Practice of component skills for Sub-STEP #3*

(7) *Practice of entire Sub-STEP #3*

(8) *Practice of all three, entire sub-STEPS--in sequence*

-If a backward order is to be used, the above sequence is simply reversed; i.e., practice begins with the component skills of Sub-STEP #3, then the entire Sub-STEP #3, the component skills of Sub-STEP #2, etc.

#2

Sub-STEP 1	Sub-STEP 2	Sub-STEP 3
Entire sub-STEP can be practiced by itself	Both Sub-STEPS #2 and #3 can be practiced together	

-If a forward order is to be used, the sequence would be as follows:

(1) *Practice of entire Sub-STEP #1*

(2) *Practice of entire Sub-STEPS #2 and #3 in sequence*

(3) *Practice of all three, entire sub-STEPS in sequence*

#3

Sub-STEP 1	Sub-STEP 2	Sub-STEP 3
Entire sub-STEP can be practiced by itself	Component skill practice is required	Entire sub-STEP can be practiced by itself

-If a backward order is to be used, the recommended sequence is as follows:

(1) *Practice of entire Sub-STEP #3*

(2) *Practice of component skills in Sub-STEP #2*

(3) *Practice of entire Sub-STEP #2*

(4) *Practice of entire Sub-STEPS #2 and #3*

(5) *Practice of all three, entire Sub-STEPS, #1, #2, and #3, in sequence*

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Adequacy of plans for sequence of practice	41

I.1.2 IDENTIFICATION MATRIX	INFORMATION TO REVIEW AS A BASIS FOR PLANNING SEQUENCE OF PRACTICE		
SOURCES	1 Prior decisions about HOW MUCH should be practiced at the same time	2 Prior decisions about SEQUENCE	3 Results of LEARNING and PERFORMANCE analyses
CRITERIA	*-Decisions made in Sub-STEP I.1.1 about whether:* *••Component skills within sub-STEPS need to be practiced separately* *••A sub-STEP can be practiced by itself in its entirety* *••Two or more sub-STEPS can be practiced together (and in their entirety)*	*-Decision made in Sub-STEP G.2.1 about:* *••Usefulness of backward chaining as a preparatory practice progression suitable for the learning problem at hand*	*-Types of learning or performance problems involved in learning criterion behavior:* *••Summarized on FORM G.1(2)*

I.1.2

DECISION MATRIX

DETERMINING SEQUENCE OF PRACTICE OF COMPONENT SKILLS WITHIN SUB-STEPS AND OF A SERIES OF WHOLE SUB-STEPS

CONDITIONS	Decision made that component skills within a sub-STEP require separate practice	Decision made that component skills require separate practice for some, but not all, sub-STEPS in a chain	Decision made that component skills require NO separate practice for any sub-STEP in the chain
ACTION TO TAKE	*-Plan to provide opportunities for practice of component skills FIRST* *••The order in which skills should be practiced is as follows:* */Re: OUTPUTS* */Re: INPUTS* */Re: ACTIONS* */Re: INPUTS and ACTIONS* *-Then, plan to provide for practice of the entire sub-STEP SECOND*	*-Always require practice concerning a sub-STEP (whether of component skills or of the whole sub-STEPS) in a systematic: forward or backward order* *-Before combining the practice of adjacent sub-STEPS always provide prior practice of component skills if any of the sub-STEPS to be combined require it*	*-Plan to provide practice in a forward or backward order of the intact sub-STEPS--either singly or in combination (as decided on in Sub-STEP I.1.1)* *-Decision about forward or backward order is based on decision made in Sub-STEP G.2.1 and on evaluation of nature of learning problem*

I.1.2

ILLUSTRATION SUMMARIZING PROCEDURES INVOLVED IN PLANNING THE SEQUENCE IN WHICH PARTS OF THE CRITERION BEHAVIOR WILL BE PRACTICED

#1

REVIEW

a. Decisions about how much can be practiced at the same time (Sub-STEP I.1.1)

b. Decisions made on FORM G.1(2) about sequence in Sub-STEP G.2.1

#2

DECIDE

a. On the order of practice of component skills within sub-STEPS

b. On the order of practice of intact sub-STEPS or combinations of intact sub-STEPS

I.1.2
STANDARDS
MATRIX

ASSESSING THE ADEQUACY OF PLANS TO SEQUENCE THE ORDER IN WHICH PARTS OF CRITERION BEHAVIOR ARE PRACTICED

PROPERTIES	RELEVANCE	COMPLETENESS
CRITERIA	*-Decision about sequence of practice is based on:* *••Prior decisions about how much can be practiced at the same time* *••Prior decisions about order (in Sub-STEP G.2.1)* *and/or* *••Current estimates about suitability for learning problem at hand*	*-Decision about sequence is based on a review of all sub-STEPS in a chain (and prior decisions about need to practice component skills for them)*

STEP I.2

I.2 Prepare instructional materials or procedures.

I.2.1 Prepare instructional materials or procedures for each sub-criterion behavior.*

I.2.2 Prepare instructional materials or procedures integrating all sub-criterion behaviors that make up the criterion behavior.

**This is a sequential activity; i.e., following completion of materials for one sub-criterion behavior, the preparation of materials for the next sub-criterion behavior begins.*

STEP I.2

OVERVIEW

INPUT	ACTION	OUTPUT
Collection of analyses for criterion behavior + Plans for breaking it into a sequence of sub-criterion behaviors	Develop instructional sequences	Instructional sequences for: -Each sub-criterion behavior -Integrating all the sub-criterion behaviors

I.2.1	Previous analysis identifying: -Content of sub-criterion behavior -Progressions to use -Scope and order of practice -Plans for behavior control i	Develop instructional sequence for (each) sub-criterion behavior ii	Instructional sequence iii
I.2.2	An instructional sequence for each sub-criterion behavior + previous decisions about order of practice iv	Prepare instructional sequence to chain all sub-criterion behaviors v	An instructional sequence to chain all sub-criterion behaviors leading to performance of the CRITERION behavior vi

STEP I.2

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I.2

IDENTIFICATION MATRIX

THREE TYPES OF PERFORMANCE STAGES IN AN INSTRUCTIONAL SEQUENCE

(Read examples first)

TYPES OF PERFORMANCE STAGES	Performance required AT THE BEGINNING of instruction	Performance required AT THE INTERMEDIATE GOALS of instruction	Performance required AT THE FINAL GOAL of instruction
CRITERIA	*-The practice problem with which the student begins instruction/training leading to the first intermediate goal in a sequence* *-The practice problem with which the student begins instruction leading to one or more additional intermediate goals*	*-Performance of sub-criterion behaviors identified in:* *••Statement(s) of (unmodified) preparatory objective* (See TASK D) *••One or more preparatory test items* (See TASK F) *••The scheduled practice of intact sub-STEPS or combinations of sub-STEPS* (See Sub-STEP I.1.1)	*-Performance of the criterion behavior identified in:* *••The statement of a criterion objective* (See TASK D) *••One or more criterion test items* (See TASK F)

	1	2	3
EXAMPLES (Read Column #3 FIRST)	e.g., first practice problem -A beginning problem having to do with one sub-criterion behavior (e.g., monetary policy) e.g., given a definition and an example, the student is required to select from two options the one which is an example of monetary policy	e.g., sub-criterion behavior -One sub-criterion behavior consists of being able to define monetary policy and to give examples of it -Another sub-criterion behavior consists of being able to define fiscal policy and to give examples of it	e.g., criterion behavior -The criterion behavior consists of being able to compare and contrast (in one's own words) fiscal policy and monetary policy

I.2

IDENTIFICATION MATRIX

INSTRUCTIONAL SEQUENCES FOR DIFFERENT CRITERION BEHAVIORS VARY DEPENDING ON THE "DISTANCE" BETWEEN INITIAL AND FINAL PERFORMANCE

TYPES OF "DISTANCE"	"Distance" between initial performance and a SUB-CRITERION behavior*	"Distance" between initial practice problem and the final CRITERION behavior
CRITERIA	*-The amount of practice it requires to take the learner from entry behavior to mastery of a sub-criterion behavior* *-The amount of practice required depends on the difficulty of the learning problem(s) involved* *-Decision made in TASK D about what will and what will not be an unmodified preparatory objective (and hence a sub-criterion behavior) can be changed in TASK I*	*-The amount of practice it requires to take the learner from entry behavior to final criterion behavior* *-The amount of practice required will depend on the number of sub-criterion behaviors that intervene between entry behavior and final CRITERION behavior* *-The amount of practice required for mastery of each of the sub-criterion behaviors* *-The amount of practice required for putting all the sub-criterion behaviors together to achieve mastery of the criterion behavior*

*A sub-criterion behavior corresponds to an "unmodified" preparatory objective.

EXAMPLES	e.g., *-A sub-criterion behavior usually involves the performance of a whole sub-STEP (or a combination of sub-STEPS)* *-If the component skills in a sub-STEP are difficult and therefore have to be practiced separately, it is possible to conclude that the "distance" between entry behavior and mastery of sub-criterion behavior will be longer than a situation in which separate practice of the component skills is not required*	e.g., *-The more sub-criterion behaviors there are, the more practice will be required to reach criterion behavior* *-The more difficult any of the sub-criterion behaviors are (See example to the left), the more practice will be required to reach criterion behavior*

I.2

IDENTIFICATION MATRIX

DESIRABLE PROPERTIES OF INSTRUCTIONAL SEQUENCES BRIDGING THE "DISTANCE" BETWEEN ENTRY BEHAVIOR AND SUB-CRITERION AND CRITERION BEHAVIOR

PROPERTIES	Instructional sequences result in student practice which is relatively ERROR FREE	The first version of an instructional sequence is as LEAN as possible
CRITERIA	*-Instructional sequences should be prepared for all students to solve practice problems in relatively error-free fashion (ideally):* *••Each practice problem results in errors committed by no more than 10 percent of the target population* *••No more than 10 percent of the practice problems result in:* */Errors committed by more than 10 percent of the population*	*CONSISTENT WITH ERROR-FREE PRACTICE* *-Instructional sequences should be prepared which are as lean as possible:* *••Provide cues or prompts that are only as strong as needed to insure correct practice (and no stronger);* *AND/OR* *••Cues or prompts are faded or withdrawn as quickly as possible* *AND/OR* *••The amount of practice preceding the practice of a sub-criterion behavior or a criterion behavior is as spare as possible*
RATIONALE	-Commission of errors requires that the student be allowed to engage in additional practice so that the error is unlearned -The primary rationale for insuring relatively error-free practice, therefore, is to: ••Insure the efficiency of instruction	-Lean programs make for efficient and cost-effective instruction -Lean programs "stretch" the student

I.2

EXAMPLES OF PRACTICE ITEMS ILLUSTRATING DIFFERING DEGREES OF "LEANNESS"

EXAMPLES

DEGREE OF LEANNESS	MOST lean	INTERMEDIATE lean	LEAST lean
STRENGTH OF CUES	e.g., Which of the following is correct? Every day at nine the man: ___walk to work ___walks to work	e.g., A singular noun requires an "s" ending on a present tense verb. Which of the following is correct? Every day at nine the man: ___walk to work ___walks to work	e.g., Singular nouns like "boy," "girl," "man," "woman," etc., require an "s" ending on a present tense verb. Which of the following is correct? Every day at nine the man: ___walk to work ___walks to work
SPEED OF FADING CUES	e.g., In a series of ten practice items leading up to a sub-criterion behavior, cues are faded: ••Completely by the 7th item ••Considerably by the 5th item ••Initially on the 2nd item	e.g., In a series of ten practice items leading up to a sub-criterion behavior, cues are faded: ••Completely by the 8th item ••Considerably by the 7th item ••Initially on the 4th item	e.g., In a series of ten practice items leading up to a sub-criterion behavior, cues are faded: ••Completely by the 9th item ••Considerably by the 8th item ••Initially on the 6th item
AMOUNT OF PRACTICE	e.g., A sequence of practice items leading up to a sub-criterion behavior consists of: ••Ten practice items	e.g., A sequence of practice items leading up to a sub-criterion behavior consists of: ••Fourteen practice items	e.g., A sequence of practice items leading up to a sub-criterion behavior consists of: ••Twenty practice items

I.2

IDENTIFICATION MATRIX

CRITERIA FOR IDENTIFYING VARYING DEGREES OF CUE STRENGTH
(See Sub-STEP G.2.1)

DEGREES OF CUE STRENGTH	MAXIMUM strength of cues	INTERMEDIATE strength of cues	MINIMUM strength of cues
CRITERIA	-Cues assist the learner to identify the solution to problems concerning any of the following: ••Discriminations ••Generalizations ••Associations ••Chains		
	-Cues provide an identification which is: *••Exact* *••Complete* *••Direct* *-They are maximum because, in effect, they give the answer away*	*-Cues provide an identification which is:* *••Inexact* *••Incomplete/partial* *••Indirect/oblique*	*-No cues are presented with the practice item* *-The just completed sequence of practice items provides the only cues (from memory)*

EXAMPLES "Use of the slide rule to multiply"	e.g., *-Instructions and examples are provided on:* *••Which scales to use for multiplication* *••How to use them* *••How to read the results*	*-The only identification made is:* *••Which scales to use*	*-No assistance is provided* *-This practice immediately follows assisted or cued practice*

I.2

IDENTIFICATION MATRIX

CRITERIA FOR IDENTIFYING VARYING SPEEDS WITH WHICH CUES OR PROMPTS (OR PROGRESSIONS IN GENERAL) ARE FADED OUT

SPEED OF FADING	RAPID fading	INTERMEDIATE fading	SLOW fading
CRITERIA	*Switch from strong to intermediate to no cues at all*		
	-Sooner in a series of practice items	*-At an intermediate time in a series of practice items*	*-Later in a series of practice items*

	Switch from one level of strength to another occurs as follows:					
EXAMPLES:	FROM:	TO:	FROM:	TO:	FROM:	TO:
A total series of 20 practice items	Exact identification	2nd practice item	Exact identification	4th practice item	Exact identification	5th practice item
	Indirect identification	9th practice item	Indirect identification	13th practice item	Indirect identification	16th practice item

I.2

IDENTIFICATION MATRIX

CRITERIA FOR IDENTIFYING VARYING AMOUNTS OF PRACTICE*

AMOUNTS OF PRACTICE	SMALL amount	INTERMEDIATE amount	LARGE amount
CRITERIA	*The number of practice items required to bring the learner from entry behavior to sub-criterion or criterion behavior* *-Small number of practice items*	*-Intermediate number of practice items*	*-Large number of practice items*
EXAMPLES *"Learning to multiply with a slide rule"*	*e.g.,* *-20 practice problems*	*e.g.,* *-35 practice problems*	*e.g.,* *-60 practice problems*

*The number of practice items developed to bring a learner up to criterion interacts with the decision made about strength of cues; the smaller the number of items used, the stronger cues are likely to be.

I.2

IDENTIFICATION
MATRIX

CRITERIA FOR IDENTIFYING CONDITIONS WHICH DETERMINE HOW "LEAN" AN INSTRUCTIONAL SEQUENCE CAN BE MADE

CONDITIONS	Conditions allowing LEANER sequences	Conditions requiring LESS LEAN sequences
CRITERIA	*Sequences for: Sub-criterion Behavior*	
	-None or few of the component skills within a sub-STEP or within a combination of sub-STEPS are very difficult to learn	*-All or most of the component skills within a sub-STEP or within a combination of sub-STEPS are very difficult to learn*
	-The scope of the sub-criterion behavior tends to be smaller (i.e., has fewer sub-STEPS making it up)	*-The scope of the sub-criterion behavior tends to be larger (i.e., has more sub-STEPS making it up)*
	Sequences for: Criterion Behavior	
	-Criterion behavior has no or few sub-criterion behaviors which are very difficult to learn	*-Criterion behavior has many sub-criterion behaviors which are very difficult to learn*
	-The total number of sub-criterion behaviors is large	*-The total number of sub-criterion behaviors is small*

PREVIEW OF THE NEXT SubSTEP

YOUR PRODUCT	*Instructional materials designed to teach each sub-criterion behavior.*
WHAT YOU WILL WORK FROM	(1) Prior analyses which have identified: ... descriptions of behavior to be learned ... preparatory progressions selected to teach it ... scope and order of practice ... plans for behavior control
WHAT YOU WILL DO	(1) Develop instructional materials for each sub-criterion behavior
FORMS YOU WILL USE	FORM 1.2(1) for developing an instructional sequence using the progression: RECOGNIZE, EDIT, PRODUCE (where applicable).

DESCRIPTION OF Sub-STEP	I.2.1

INPUT	ACTION	OUTPUT
Previous analysis identifying: -Content of sub-criterion behavior -Progressions to use -Scope and order of practice -Plans for behavior control i	Develop instructional sequence for (each) sub-criterion behavior ii	Instructional sequence iii

Job Aid Contents

CRITERIA FOR IDENTIFYING INPUTS	ACTION TO BE TAKEN	STANDARD FOR OUTPUTS	FORMS TO USE
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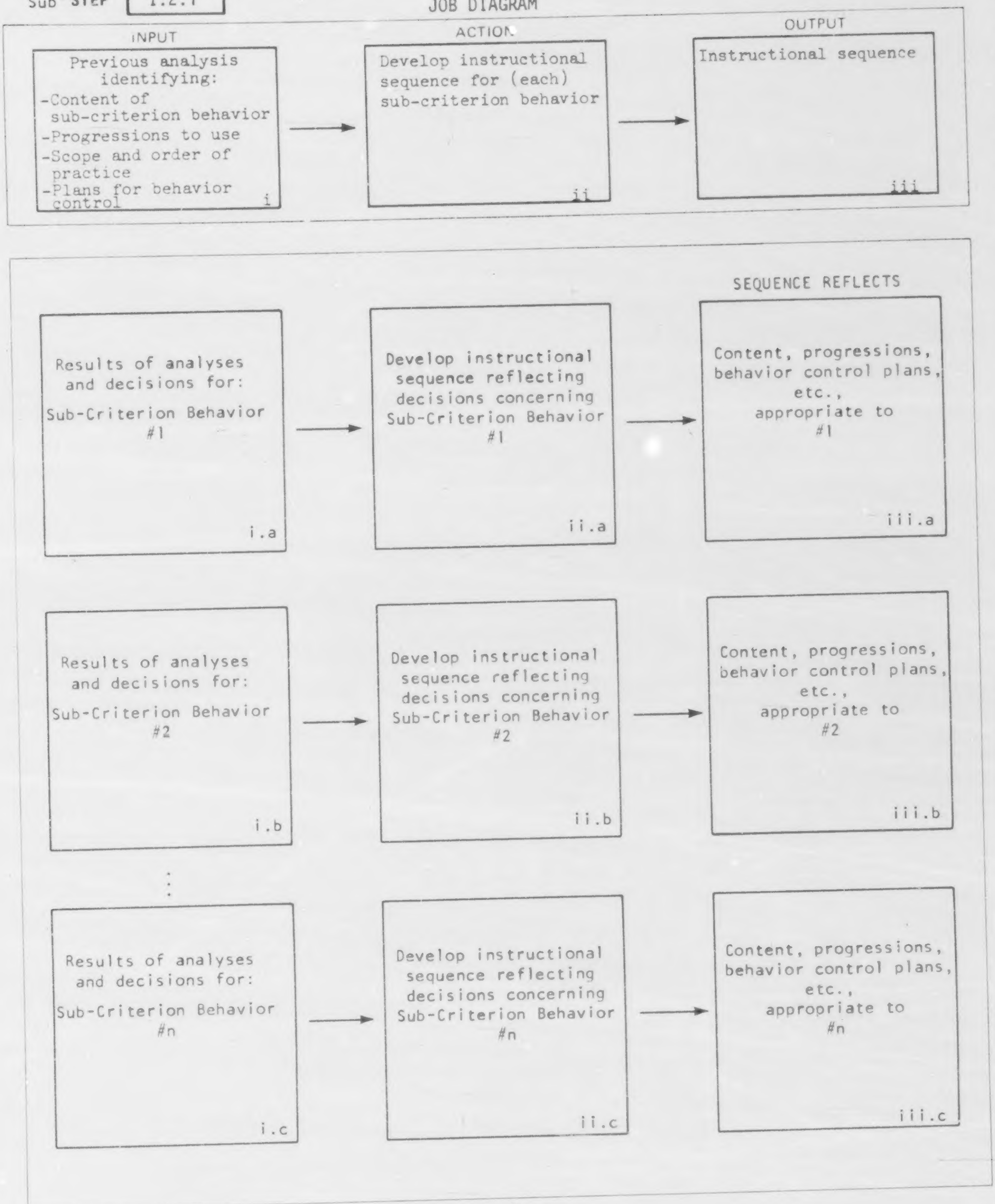
Required Materials

COMPLETED MATERIALS	STEP	COMPLETED FORMS	STEP	BLANK FORMS
Decision about scope of sub-criterion behavior practice	I.1.1	Collection of FORMS carried forward from	H.1.2	FORM I.2(1) (where applicable)
Decision about order of sub-criterion behavior practice	I.1.2			

Sub- **STEP** I.2.1

JOB DIAGRAM



INPUT

Previous analysis identifying:
- Content of sub-criterion behavior
- Progressions to use
- Scope and order of practice
- Plans for behavior control

i

ACTION

Develop instructional sequence for (each) sub-criterion behavior

ii

OUTPUT

Instructional sequence

iii

SEQUENCE REFLECTS

Results of analyses and decisions for: Sub-Criterion Behavior #1 — i.a

Develop instructional sequence reflecting decisions concerning Sub-Criterion Behavior #1 — ii.a

Content, progressions, behavior control plans, etc., appropriate to #1 — iii.a

Results of analyses and decisions for: Sub-Criterion Behavior #2 — i.b

Develop instructional sequence reflecting decisions concerning Sub-Criterion Behavior #2 — ii.b

Content, progressions, behavior control plans, etc., appropriate to #2 — iii.b

Results of analyses and decisions for: Sub-Criterion Behavior #n — i.c

Develop instructional sequence reflecting decisions concerning Sub-Criterion Behavior #n — ii.c

Content, progressions, behavior control plans, etc., appropriate to #n — iii.c

BACKGROUND INFORMATION
FOR SUB-STEP I.2.1

	page
NOTE about coverage in this section	61
Two possible orders in which the developer can proceed when preparing instructional materials	62
FORM I.2(1) for use when developing instructional sequences	63
Advantages derived from a "reverse" order of materials development	64
EXAMPLES illustrating sequences varying in leanness	65
Variations possible in the number of practice items possible with each type of assistance (i.e., no intermediate, or maximum)	66
Leanness of an instructional sequence depends both on the number of practice items and the type(s) of assistance provided	67
Examples of other "progressions" varying in degrees of assistance	68
Some representative instructional sequences	69

*NOTE

Both the development process (this TASK) and the tryout and revision process (the next TASK) can more adequately and more concisely be illustrated using paper-and-pencil instructional materials. Accordingly the remaining treatment of Sub-STEPS I.2.1 and I.2.2 is restricted to the use of printed examples to illustrate procedures involved in the development process.

A discussion of the preparation of other instructional sequences (either involving actual objects, people, events, or involving other media such as film, TV, tape, slides) is omitted.

* *NOTE

When materials development requires the use of media, like film, TV, tape, or slides, multiple cycles of tryout and revisions can dangerously inflate development costs. Therefore, it is advisable particularly during informal tryouts, when program bugs are most likely to be identified, to work with story board materials. Materials less costly than film or TV can be used to detect program weaknesses. Such materials as paper-and-pencil exercises, cardboard mock-ups, live demonstrations, etc. can be used for these purposes.

Ultimately, when the product of the initial tryout and revision process is transferred to the more costly film or TV media, the program must also be tried out in this form. The prior tryout in storyboard form reduces the likelihood that major changes in filmed or televised revisions will be required.

LESSON ☐ *(SUB-) CRITERION BEHAVIOR* ☐

	MAXIMUM ASSISTANCE	INTERMEDIATE ASSISTANCE	NO ASSISTANCE
RECOGNIZE	Students start here Developer may start here *A*	*B*	*C*
EDIT	*D*	*E*	*F*
PRODUCE	*G*	*H*	Developer may start here *I*

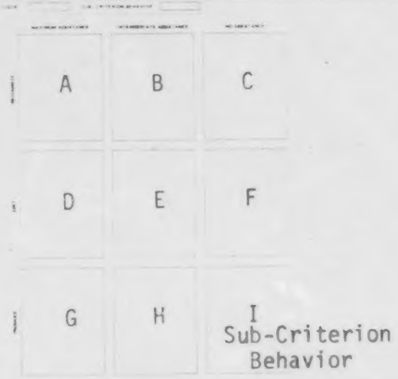
I.2.1
IDENTIFICATION
MATRIX

ADVANTAGES TO BE DERIVED FROM DEVELOPING INSTRUCTIONAL MATERIALS IN THE REVERSE ORDER (I.E., FROM SUB-CRITERION PRACTICE BACK TO BEGINNING PRACTICE)

ADVANTAGES	EASE IN JUDGING HOW MUCH ASSISTANCE IS NEEDED	PROBABLE DEGREE OF LEANNESS	EASE IN MAKING REVISIONS
CRITERIA	-It is relatively easy to judge how much assistance needs to be provided directly to the sub-criterion behavior in Cell I (See below) in order to facilitate student ability to perform it (This addition of assistance produces Cell H) -If it is further judged that adding assistance to I has not been sufficient, that is, H also cannot be performed, further assistance can be provided as in Cell G (and so on back toward the beginning--as needed) -It is relatively more difficult to estimate how many intervening steps are likely to be required if the developer starts at Cell A	-By working backwards, it is more likely that the developer will stop adding assistance sooner (based on the easier judgments of its need) than if he works in a forward direction -A leaner first draft of an instructional sequence is likely to result	-By working backwards, it is possible during tryouts to revise the first draft in a systematic way -It is easier to decide how much and what type of assistance to add (adding in as economic way as possible; i.e., as little as is needed) -In a forward order it is less likely to be obvious at what point to intervene

FORM I.2(1)

EXAMPLE



I.2.1

EXAMPLES OF SEQUENCES VARYING IN LEANNESS
(REFER TO FORM AT BOTTOM OF PAGE 64)

EXAMPLES	WHAT THE SEQUENCE CONSISTS OF	
#1	MAXIMUM LEANNESS POSSIBLE -Cells H and I only	MINIMUM LEANNESS -Cells A through I
#2	LEANER -Cells G, H, and I	LESS LEAN -Cells F, G, H, and I
#3	LEANER -Cells F, G, H, and I	LESS LEAN -Cells D, E, F, G, H, and I
#4	LEANER -Cells D, E, F, G, H, and I	LESS LEAN -Cells B, C, D, E, F, G, H, and I

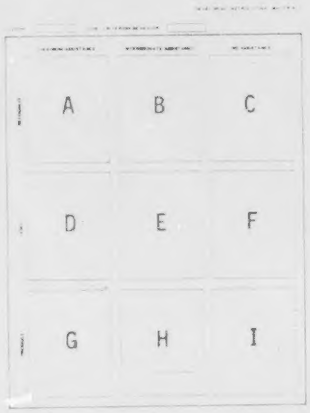
I.2.1

IDENTIFICATION MATRIX

VARIATIONS POSSIBLE IN THE NUMBER OF PRACTICE ITEMS FOR EACH TYPE OF ASSISTANCE (FOR EACH MODE OF RESPONDING)

POSSIBLE NUMBER OF PRACTICE ITEMS	ZERO	ONE or MORE
CRITERIA	*-Any of the cells A through H can be omitted in an instructional sequence* *-Within any row of FORM I.2(1)--a cell with stronger assistance is more apt to be omitted than one with weaker or no assistance*	*-Cell I has to have at least one practice item (a sub-criterion practice item)* *-Cell I may have more than one practice item* *-Cells A-H may have one or more practice items (but the aim is to have as few as are needed to bring the learner up to mastery of the sub-criterion behavior)*

FORM I.2(1)



A	B	C
D	E	F
G	H	I

I.2.1

IDENTIFICATION
MATRIX

VARIATIONS IN LEANNESS OF AN INSTRUCTIONAL SEQUENCE
DEPENDS BOTH ON: (1) VARIETY OF TYPES OF ASSISTANCE AND
(2) NUMBER OF PRACTICE ITEMS
(3) AMOUNT PRACTISED AT SAME TIME.

TYPES OF VARIATION	NUMBER OF PRACTICE ITEMS	VARIETY IN TYPES OF ASSISTANCE (WITHIN A GIVEN DEGREE OF ASSISTANCE)	AMOUNT OF BEHAVIOR PRACTICED AT THE SAME TIME
CRITERIA	*-Each of the cells in the diagram on the previous page can be represented in an instructional sequence by:* *••No practice items* *••One or more practice items* *-The leanness of the instructional sequence is a function of the total number of practice items:* *••The fewer the number, the leaner the sequence*	*-Leanness is a function:* *••How many of the types of assistance (none, intermediate, or maximum) are offered* *••Whether these types are offered for each type of practice (recognition, editing, and production)* *••Variations in degree of assistance within a given type (e.g., varying degrees of "intermediate" assistance)*	*-Leanness is a function of how much of sub-criterion behavior is practiced at the same time* *..The more parts of a sub-criterion behavior practiced at the same time, the leaner the sequence* *..The more the sub-criterion behavior is broken up into parts, with each part practiced separately, the less lean the sequence*

*Leanness, however, is a joint function of the number of items and the kind of items they are (in terms of the variables identified in the remaining columns on this page).

1.2.1

EXAMPLES

EXAMPLES OF OTHER PROGRESSIONS (OTHER THAN R-E-P) VARYING IN LEANNESS*

**Progressions are identified by lower case letters (a-q) as in Sub-STEP G.2.1 in Section G.*

DEGREE OF LEANNESS*	LEANER	LESS LEAN
#1 (o) Repetition (p) Review (q) Varied examples	-The number of practice items used to implement these progressions is smaller ••Fewer repetition items are used ••Fewer review items are used ••Fewer examples are used	-The number of practice items used to implement these progressions is larger ••More repetition items are used ••More review items are used ••More examples are used
#2 (f) Examples or demonstrations (g) Verbal cues (h) Visual cues (i) Diagramming	-The cues provided with other types of progressions: ••Provide less or weaker assistance ••Are faded out more quickly	-The cues provided with other types of progressions: ••Provide more or stronger assistance ••Are faded out more slowly
#3 (a) Shaping (n) Backward chaining	-Shaping or backward chaining occurs less gradually (consistent with "no errors" policy) ••Bigger jumps ••Fewer practice items	-Shaping or backward chaining occurs more gradually ••Smaller jumps ••More practice items
#4 Other progressions (c), (d), (e), (j), (k), (i), (m)	-The number of practice items used to implement these progressions is smaller	-The number of practice items used to implement these progressions is larger

SOME REPRESENTATIVE INSTRUCTIONAL SEQUENCES*

	page
Amount of sub-criterion behavior dealt with at the same time (FOUR EXAMPLES: 1-4)	70
Some major types of instructional sequences (THREE EXAMPLES: 5-7)	71
Subject matter to be used in the remainder of this section	74, 75

**The following sections containing varied types of instructional sequences will use the* *same* *subject matter as examples. This will call attention to variations in sequences rather than to subject matter. Because the subject matter will remain the same throughout, the examples used may not represent the best matching of instructional problem and instructional solution. In other words, techniques being illustrated may not be ideal ones for the subject matter at hand. Consider these examples, therefore, as hypothetical.*

I.2.1

IDENTIFICATION MATRIX

FOUR APPROACHES TO DEALING WITH A SUB-CRITERION BEHAVIOR WHICH ARE TO BE ILLUSTRATED

	1	2	3	4
TYPE OF APPROACH	Instruction for each COMPONENT SKILL separately	Instruction for combinations of COMPONENT SKILLS	Instruction for a whole sub-STEP	Instruction for a combination of whole sub-STEPS
CRITERIA	*-Each component skill will be taught separately* *-A separate sequence of practice items will deal with each of the following:* *••Discriminations and generalizations for OUTPUTS* *••Discriminations and generalizations for INPUTS* *••Association of INPUT and ACTION*	*-Combinations of component skills will be taught at the same time* *-A sequence of practice items will be devoted to two or more component skills*	*-A whole sub-STEP will be taught at the same time* *-A sequence of practice items will be devoted to the whole sub-STEP (thereby dealing with all the component skills within the same sequence at the same time)*	*-A combination of two or more sub-STEPS will be taught at the same time* *-A sequence of practice items will be devoted to a combination of two or more sub-STEPS*
SEE PAGE	77	83	87	93

I.2.1

IDENTIFICATION MATRIX

THREE TYPES OF PREPARATORY PROGRESSIONS TO BE ILLUSTRATED, ANY ONE OF WHICH MAY BE APPLIED TO ANY OF THE FOUR APPROACHES ILLUSTRATED ON THE OPPOSITE PAGE

SEQUENCES TO BE ILLUSTRATED	5 Progression (b): R-E-P	6 Progression (i): DIAGRAMMING	7 Progression (a): SHAPING
CRITERIA	*-An instructional sequence involving a progression which includes:* *••Recognition, editing, and production practice* + *••Assistance of varying degrees offered for each type of practice*	*-An instructional sequence involving a progression which includes:* *••Use of diagrams* + *••R-E-P types of practice*	*-An instructional sequence involving a progression which includes:* *••Shaping of gradually increased performance scope* + *••Assistance of varying degrees*
SEE PAGES	98, 99, 100	102, 103, 104	106, 107, 108

ILLUSTRATIVE INSTRUCTIONAL SEQUENCES*

	page
Concept used in all the illustrative sequences	74, 75
(1) Each component skill treated separately	77
(2) Component skills treated in combination	83
(3) The entire sub-STEP treated as a whole	87
(4) A combination of sub-STEPS treated together	93
(5) A sequence illustrating an R-E-P progression	97
(6) A sequence illustrating the use of progression involving a diagram	102
(7) A sequence illustrating a "shaping" progression	105

THE ILLUSTRATIVE SEQUENCES PROVIDED ARE INTENTIONALLY KEPT LEAN.

SUBJECT MATTER USED IN ALL THE ILLUSTRATIVE SEQUENCES WHICH FOLLOW

Criterion Behavior: The student states in his own words the relationship between balanced and unbalanced forces and movement of objects. He cites examples.

Six Sub-Criterion Behaviors: The student will be able to define in his own words and to cite examples of each of the following concepts:

- --Force
- --Direction of force
- --Strength of force
- --Objects at rest
- --Objects in movement
- --Balanced force/unbalanced force

The sections that follow (except for one) will deal with only one of these sub-criterion behaviors. (See opposite page)

STATEMENT OF OBJECTIVES TO BE GIVEN STUDENTS

(1) At the end of this section you will be able to define in your own words the concept, "direction of force," and to provide examples of it.

(2) To be able to do that: You will have to be able:

  (a) To tell the difference between four different directions in which a force can be applied; and

  (b) To label the direction of a force, whether a pulling or a pushing force.

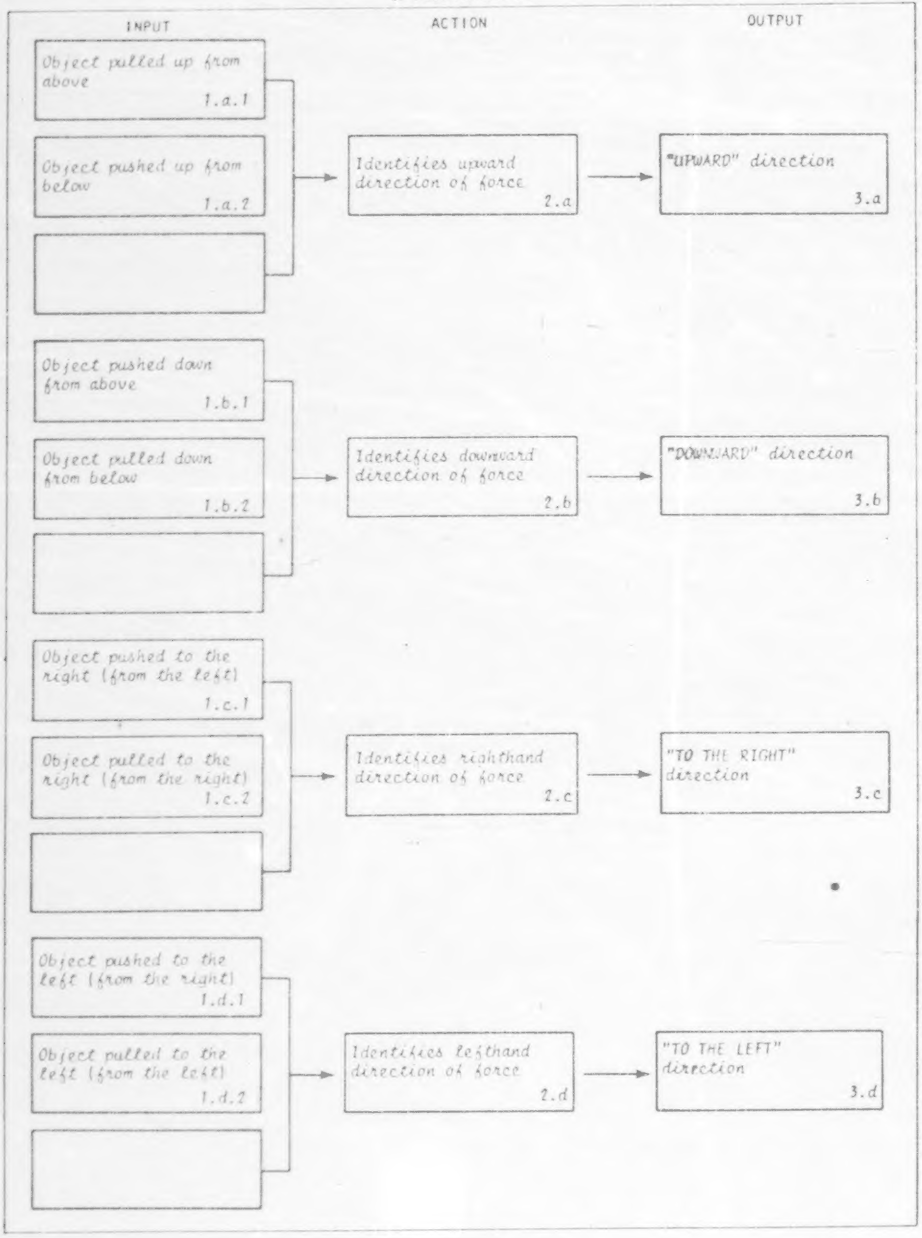
FOLD OUT PAGE

Page 76 inside contains a task analysis diagram relating to "direction" of a force. Refer to it as necessary; then review the illustrative sequences which follow.

CONCEPT USED IN THE ILLUSTRATIVE SEQUENCES WHICH FOLLOW

"DIRECTION" OF A FORCE

b. TASK ANALYSIS


INPUT
ACTION
OUTPUT
Object pulled up from above 1.a.1
Object pushed up from below 1.a.2
Identifies upward direction of force 2.a
"UPWARD" direction 3.a
Object pushed down from above 1.b.1
Object pulled down from below 1.b.2
Identifies downward direction of force 2.b
"DOWNWARD" direction 3.b
Object pushed to the right (from the left) 1.c.1
Object pulled to the right (from the right) 1.c.2
Identifies righthand direction of force 2.c
"TO THE RIGHT" direction 3.c
Object pushed to the left (from the right) 1.d.1
Object pulled to the left (from the left) 1.d.2
Identifies lefthand direction of force 2.d
"TO THE LEFT" direction 3.d

ILLUSTRATIVE SEQUENCE*

	page
(1) Each component skill is treated separately**	78

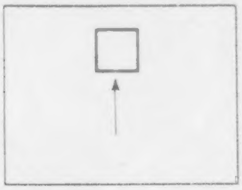
*The sequence which follows is designed to illustrate how component skills are treated separately; it is not designed to illustrate a necessarily ideal sequence for each component skill.

**It is assumed that separate treatment is required, although the actual example used may not require it.

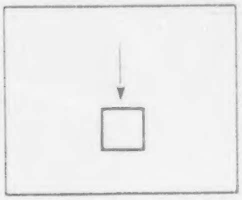
*

A. Discriminations and Generalizations Regarding: OUTPUTS

A.1 The arrow represents a force being applied to the box in an upward direction.

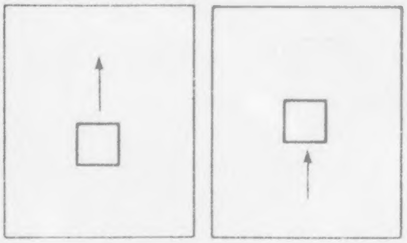


In what direction is this force being applied?



___upward   _*X*_downward

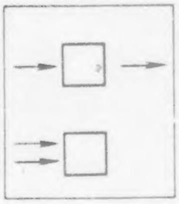
A.2



These two forces are both acting in which direction?

_*X*_upward   ___downward

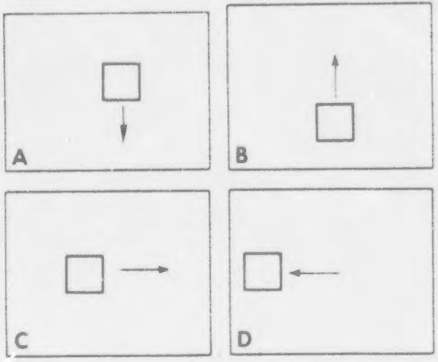
A.3



The arrows are pointing to the right. Therefore, in which direction are all these forces being applied?

_*X*_to the right   ___to the left

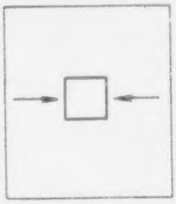
A.4



Write in the letter in the appropriate blank indicating the direction of the force.

_*C*_to the right   _*D*_to the left

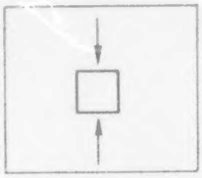
A.5



The two forces shown are acting in which two directions?

A right-hand and left-hand direction

A.6



The two forces shown are acting in which two directions?

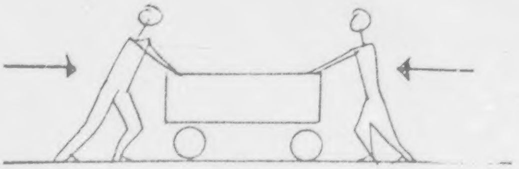
In an upward and a downward direction

Continued

**Answers are supplied in "script" typeface.*

B. Discriminations and Generalizations Regarding: INPUTS

B.1



These two men are on

___ the same side of the cart

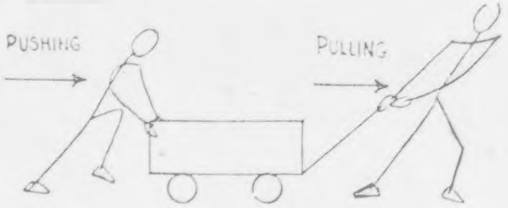
_X_ different sides of the cart

B.2 The two men in Problem #1 are pushing the cart

___ in the same direction

_X_ in different directions

B.3



These two men are on

___ the same side of the cart

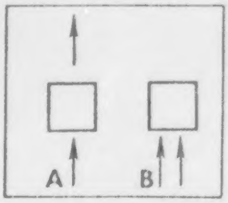
_X_ different sides of the cart

B.4 The two men in Problem #3 are applying a force to the cart

_X_ in the same direction

___ in opposite directions

B.5



In which example are the forces being applied to different sides of the box?

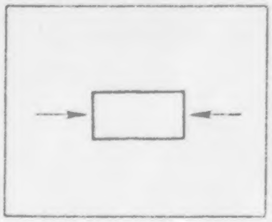
_X_ A ___ B

B.6 The forces in Problem #5 are being applied

_X_ in the same direction

___ in different directions

B.7



The forces being applied to this box are being applied

___ from the same side

_X_ from different sides

___ in the same direction

_X_ in different directions

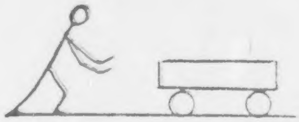
NOTE: *This sequence is designed to facilitate learning to*

- .. *discriminate between forces which are applied in the same and opposite directions*
- .. *generalize across forces applied in the same direction even though applied to different sides of an object.*

Continued

C. Associating INPUTS and ACTIONS (and Producing an OUTPUT)

C.1



On which side of the cart is this man?

X left-hand side

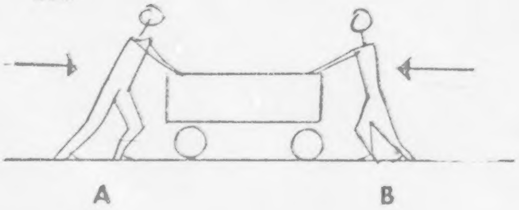
___ right-hand side

In which direction is he applying a force?

X to the right

___ to the left

C.2



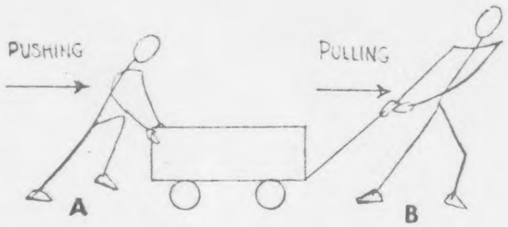
In which direction is Man A applying a force?

In a right-hand direction

In which direction is Man B applying a force?

In a left-hand direction

C.3



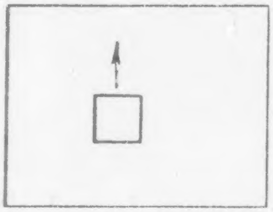
In which direction is Man A applying a force?

In a right-hand direction

In which direction is Man B applying a force?

In a right-hand direction

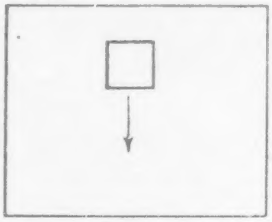
C.4



In which direction is this force being applied?

In an upward direction

C.5



In which direction is this force being applied?

In a downward direction

NOTE: *This sequence is designed to facilitate leaning of*

.. the association between the illustrated direction of a force (INPUT) and the labeling of the direction (ACTION).

Continued

D. Exhibiting the Whole Sub-Criterion Behavior (i.e., Entire Sub-STEP)

D.1 What are some of the directions in which a force can be applied to an object?

Up, down, right, left

D.2 When the sergeant tells recruits to carry their own bags, what kind of force is he telling them to apply to the bags?

A force applied in an upward direction

D.3 Cite two different ways you might apply a right-hand force to a table.

You can push it (from the left) or pull it (from the right)

D.4 When a sign instructs train passengers to pull the emergency cord, what is it instructing passengers to do?

To apply a downward force to it

D.5 What do we mean by the direction of a force? Give two contrasting examples different from the ones used here.

Whether a push or a pull applied to the object is toward the right, left, up, or down

THE END

ILLUSTRATIVE SEQUENCE*

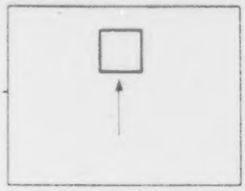
	page
(2) Component skills treated in combination**	84

*The sequence which follows is designed to illustrate how component skills are treated in combination; it is not designed to illustrate a necessarily ideal sequence for each component skill.

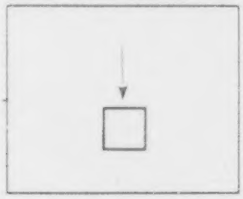
**It is assumed that combined treatment is acceptable or required, although the actual example used may not require it.

A. Discriminations and Generalizations Regarding: OUTPUTS

A.1 The arrow represents a force being applied to the box in an upward direction.

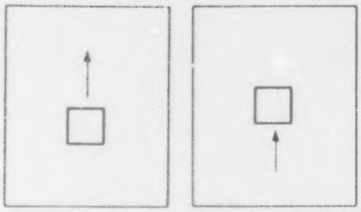


In what direction is this force being applied?



___ upward   X downward

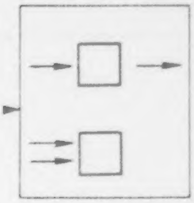
A.2



These two forces are both acting in which direction?

X upward   ___ downward

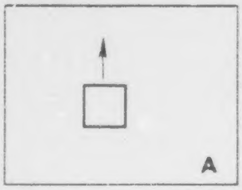
A.3

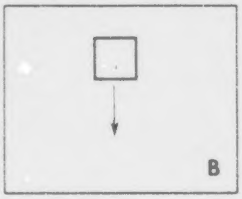


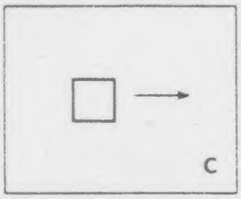
The arrows are pointing to the right. Therefore, in which direction are all these forces being applied?

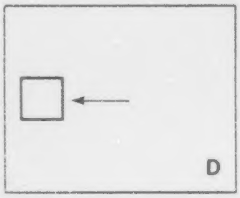
X to the right   ___ to the left

A.4





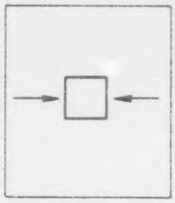




Write in the letter in the appropriate blank indicating the direction of the force.

C to the right   D to the left

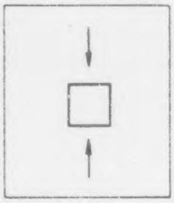
A.5



The two forces shown are acting in which two directions?

A right-hand and left-hand direction

A.6



The two forces shown are acting in which two directions?

In an upward and a downward direction

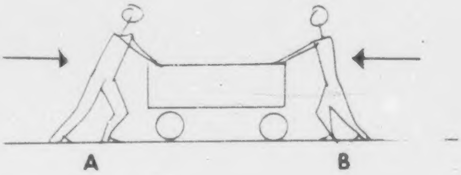
Continued

B. Discriminations and Generalizations Regarding: INPUTS

PLUS

C. Associating INPUTS and ACTIONS (and Producing an OUTPUT)

BC.1



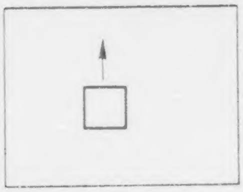
In which direction is
Man A applying a force?

A right-hand direction

In which direction is
Man B applying a force?

A left-hand direction

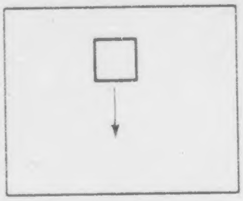
BC.2



In which
direction
is this
force being
applied?

In an upward direction

BC.3



In which
direction is
this force
being applied?

In a downward direction

Continued

D. Exhibiting the Whole Sub-Criterion Behavior (i.e., Entire Sub-STEP)

D.1 What are some of the directions in which a force can be applied to an object?

Up, down, right, left

D.2 When the sergeant tells recruits to carry their own bags, what kind of force is he telling them to apply to the bags?

A force applied in an upward direction

D.3 Cite two different ways you might apply a right-hand force to a table.

You can push it (from the left) or pull it (from the right)

D.4 When a sign instructs train passengers to pull the emergency cord, what is it instructing passengers to do?

To apply a downward force to it

D.5 What do we mean by the direction of a force? Give two contrasting examples different from the ones used here.

Whether a push or a pull applied to the object is toward the right, left, up, or down

THE END

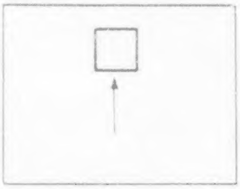
ILLUSTRATIVE SEQUENCE

	page
(3) The entire Sub-STEP treated as a whole*	88

*It is assumed that the entire Sub-STEP can be treated as a whole without having to treat component skills separately. The example used might not, in an actual instructional situation, permit this.

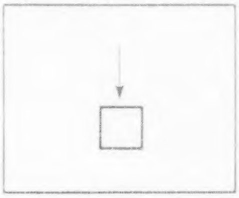
A. Discriminations and Generalizations Regarding: O[illegible]UTS
PLUS
B. Discriminations and Generalizations Regarding: IN[illegible]
PLUS
C. Associating INPUTS and ACTIONS (and Producing an OUTPUT)

ABC.1 The arrow represents a force from below the box being applied to the box in an upward direction.



In what direction is this force being applied?

_X_ upward ___downward

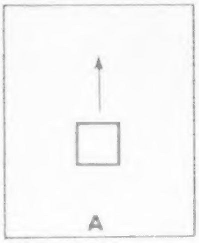


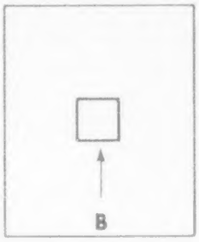
The force is being applied

_X_ from above the box

___from below the box

ABC.2





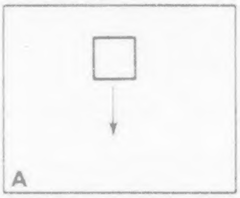
These two forces are both being applied to the box in which direction?

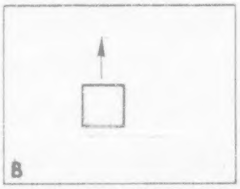
_X_ upward ___downward

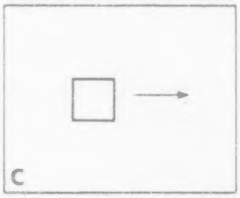
Which of the forces is being applied from the top?

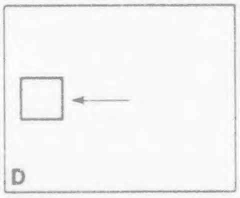
_X_ A ___B

ABC.3







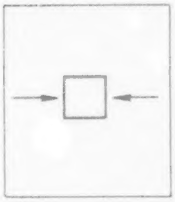


Write in the letter in the appropriate blank indicating the direction of the force.

_C_ to the right _D_ to the left

_B_ upward _A_ downward

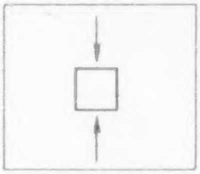
ABC.4



The two forces shown are acting in which two directions?

A right-hand direction and left-hand direction

ABC.5



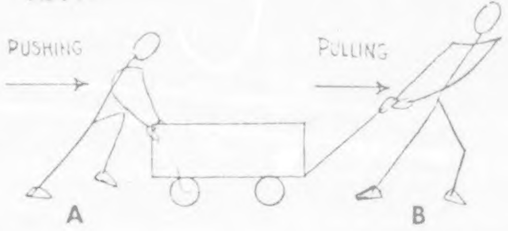
The two forces shown are acting in which two directions?

In an upward and downward direction

Continued

A. Discriminations and Generalizations Regarding: OUTPUTS
PLUS
B. Discriminations and Generalizations Regarding: INPUTS
PLUS
C. Associating INPUTS and ACTIONS (and Producing an OUTPUT) (Continued)

ABC.6



In which direction is Man B applying a force?

In a right-hand direction

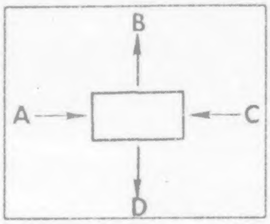
In which direction is Man A applying a force?

In a right-hand direction

From which side of the wagon are Man A and Man B applying the force?

A from the left; B from the right side

ABC.7



Describe the direction in which the four forces are being applied to the box and also the side of the box on which each one is being applied.

A is being applied from the left of the box to the right

B is being applied from above ir an upward direction

C is being applied from the right in a left-hand direction

D is being applied from below in a downward direction

Continued

D. Exhibiting the Whole Sub-Criterion Behavior (i.e., Entire Sub-STEP)

D.1 What are some of the directions in which a force can be applied to an object?

Up, down, right, left

D.2 When the sergeant tells recruits to carry their own bags, what kind of force is he telling them to apply to the bags?

A force applied in an upward direction

D.3 Cite two different ways you might apply a right-hand force to a table.

You can push it (from the left) or pull it (from the right)

D.4 When a sign instructs train passengers to pull the emergency cord, what is it instructing passengers to do?

To apply a downward force to it

D.5 What do we mean by the direction of a force? Give two contrasting examples different from the ones used here.

Whether a push or a pull applied to the object is toward the right, left, up, or down

THE END

ILLUSTRATIVE SEQUENCE

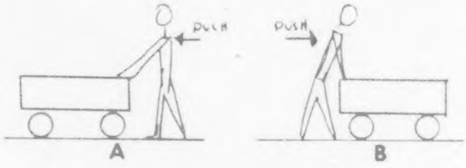
	page
(4) A combination of Sub-STEPS treated together*	94
**	

The first of the Sub-STEPS involves the concept, "direction of force" as in the previous three examples; the second Sub-STEP involves the concept, "direction of movement."

***CONTRAST THIS TREATMENT WITH THAT SHOWN IN SUB-STEP I.2.2 WHERE EACH SUB-STEP, TREATED AS A SEPARATE SUB-CRITERION BEHAVIOR, IS THEN INTERRELATED TO THE OTHER TO TEACH THE CRITERION BEHAVIOR.*

A. Combination of Sub-STEPS

A.1


PUSH
PUSH
A
B

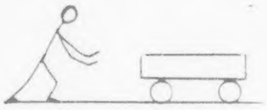
Man A is pushing in a left-hand direction. The cart will also move in

a left-hand direction

A.2 In the above illustration, Man B is applying a force to the cart in a right-hand direction. In what direction will the cart move?

To the right

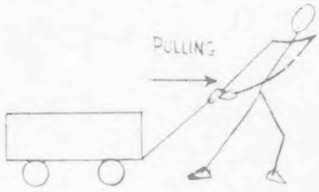
A.3



The cart is moving to the right. In what direction must the man have applied a force to it?

To the right

A.4



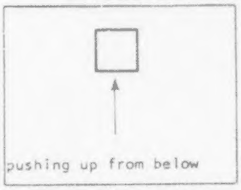
In what direction is a force being applied to the cart?

To the right

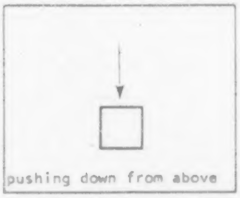
In what direction will the cart move?

To the right

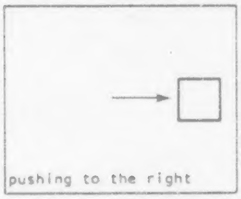
A.5 Alongside each of the following items, write in the direction in which the box will move.


pushing up from below

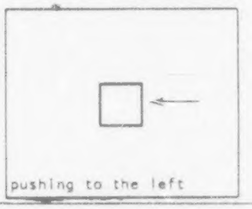
Upward


pushing down from above

Downward


pushing to the right

To the right

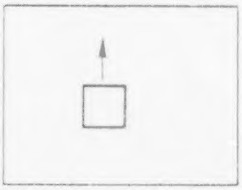

pushing to the left

To the left

Continued

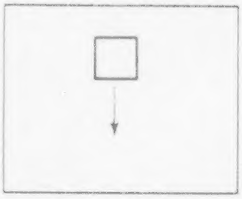
A. Combination of Sub-STEPS (Continued)

A.6 Alongside each of the following examples write in two things: the direction of the force and the direction of the movement.



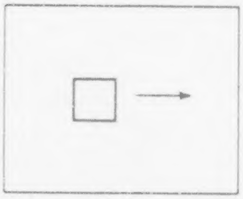
Force upward

Movement upward



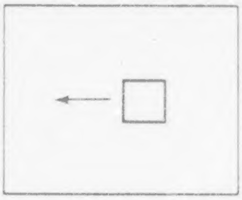
Force downward

Movement downward



Force to the right

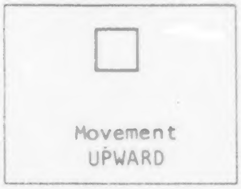
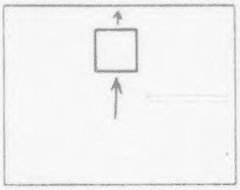
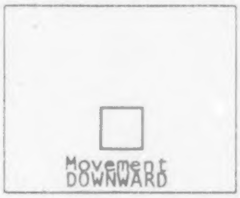
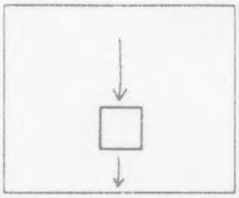
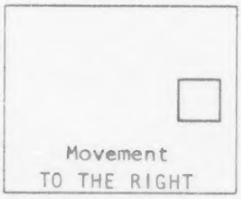
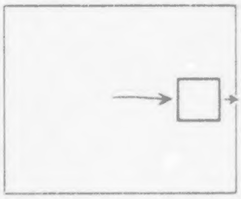
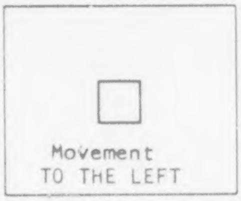
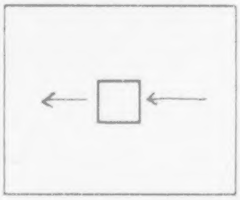
Movement to the right



Force to the left

Movement to the left

A.7 For each illustration below draw in two arrows indicating the two ways forces can be applied to produce the motion required.

PROBLEM	ANSWER
 Movement UPWARD	
 Movement DOWNWARD	
 Movement TO THE RIGHT	
 Movement TO THE LEFT	

Continued

A. Combination of Sub-STEPS (Continued)

If a man pulls a chair toward him, in what direction will the chair move?

Depends on what direction the man is pulling toward

What must a bunch of men do to get a stalled car moving again?

Push it forward or pull it forward

If you apply a downward force to a floating rubber raft, what will happen?

The raft will move downward

What must a tow truck do to get a stalled auto moving forward?

Pull it in a forward direction

What does it require for piano movers to get a piano up to the tenth floor of a building?

They have to apply a force to the piano in an upward direction

How are the direction of a force and the direction of movement related? Give two examples not used here.

-The lift applied to an airplane wing causes the plane to move upward.

-The force applied to the right by a pitcher causes the ball to travel in a right-hand direction.

-The direction of a force and the movement of the object to which it is applied are identical.

THE END

INSTRUCTIONAL SEQUENCES ILLUSTRATING THREE TYPES OF PREPARATORY PROGRESSIONS*

	page
(5) A sequence illustrating an R-E-P progression	97
(6) A sequence illustrating the use of progression involving a diagram	101
(7) A sequence illustrating a "shaping" progression	105

*THE ILLUSTRATIVE SEQUENCES PROVIDED ARE INTENTIONALLY KEPT LEAN.

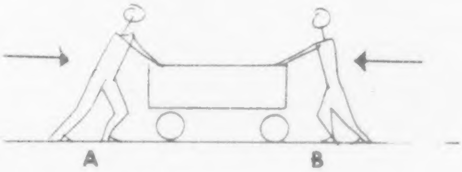
ILLUSTRATIVE SEQUENCE

	page
(5) A sequence illustrating an R-E-P progression*	98

**The example provided is primarily designed to illustrate a recognize-edit-produce sequence; the treatment of the component skills (treated here altogether), therefore, may be neither the ideal one for the example being used nor necessarily the leanest sequence appropriate to the learning problem at hand. However, an R-E-P sequence does make it possible to teach for more of a Sub-STEP at the same time.*

A. RECOGNIZE

A.1



These two men are on

___the same side of the cart

X different sides of the cart

A.2 Man A in Illustration #1 is pushing the cart

X in a right-hand direction

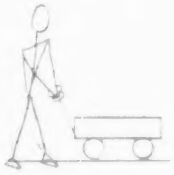
___in a left-hand direction

A.3 Man B in Illustration #1 is pushing the cart

___in a right-hand direction

X in a left-hand direction

A.4

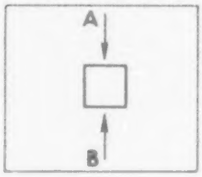


This man is applying a force in

___a right-hand direction

X a left-hand direction

A.5



Forces A and B are

___on the same side of the box

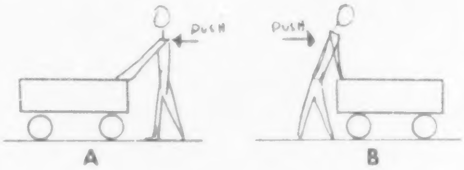
X on different sides of the box

A.6 Force A in Illustration #5 is being applied in

X a downward direction

___an upward direction

A.7



Which force is being applied on the left-hand side of the cart?

___A X B

A.8 Which force in Illustration #7 is being applied in a left-hand direction?

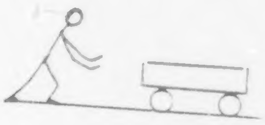
X A ___B

Continued

B. EDIT

In the following problems, if a statement is correct, do nothing; if it is incorrect, change it and make it correct.

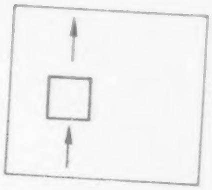
B.1



"A push was applied from the left-hand side of the cart--in a left-hand direction."

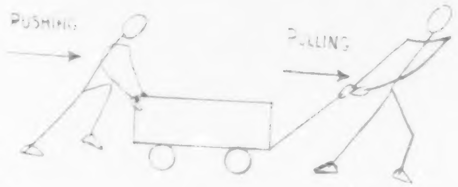
In a right-hand direction

B.2



"These forces are being applied in the same direction."

B.3



"The forces in the above illustration are being applied to different sides of the cart and are being applied in different directions."

They are being applied in the same direction, to the right.

Continued

C. PRODUCE

C.1 What are some of the directions in which a force can be applied to an object?

Up, down, right, left

C.2 When the sergeant tells recruits to carry their own bags, what kind of force is he telling them to apply to the bags?

A force applied in an upward direction

C.3 Cite two different ways you might apply a right-hand force to a table.

You can push it (from the left) or pull it (from the right)

C.4 When a sign instructs train passengers to pull the emergency cord, what is it instructing passengers to do?

To apply a downward force to it

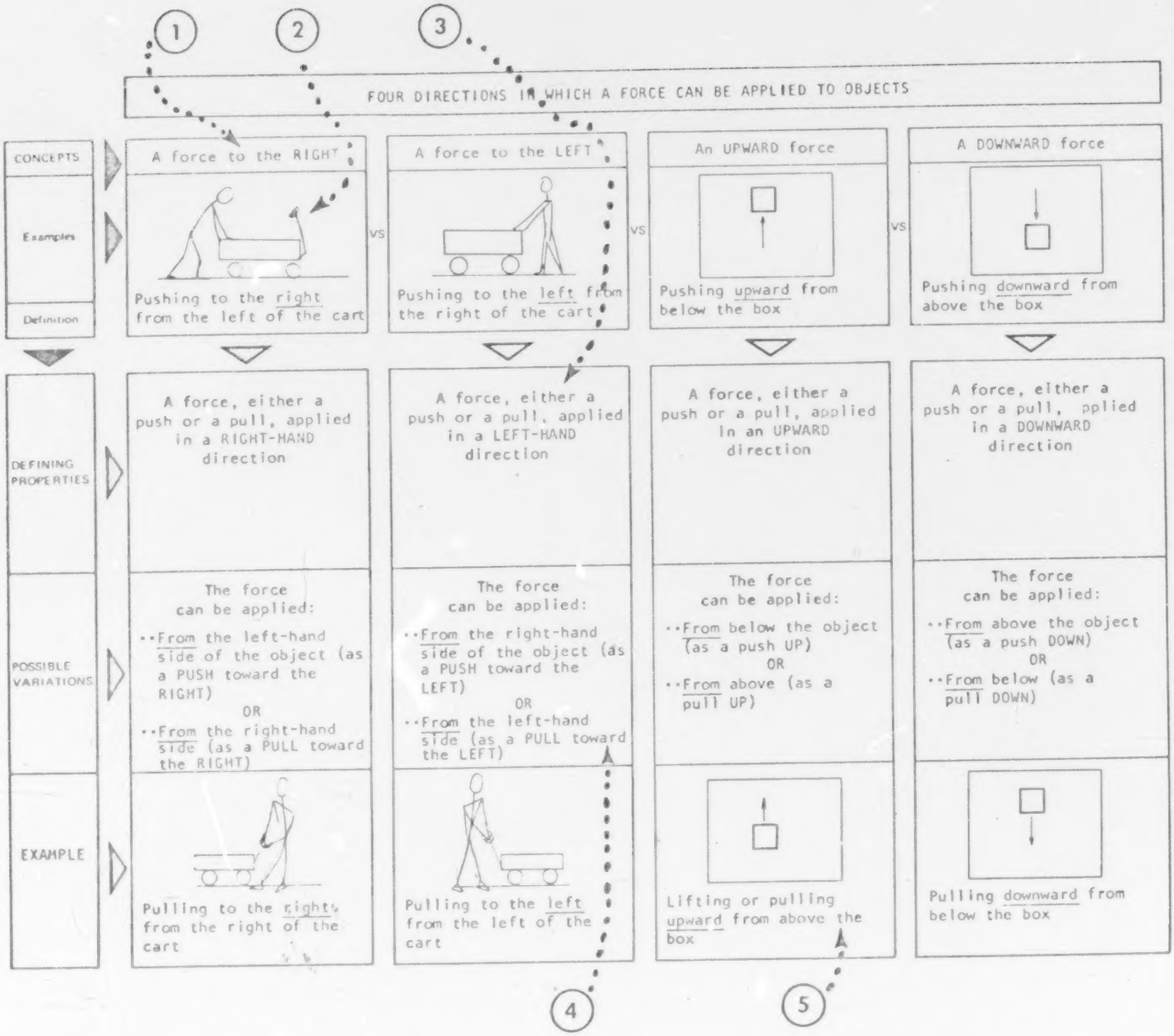
C.5 What do we mean by the direction of a force? Give two contrasting examples different from the ones used here.

Whether a push or a pull applied to the object is toward the right, left, up, or down

THE END

ILLUSTRATIVE SEQUENCE

	page
(6) A sequence illustrating a progression using a diagram	102
SEE VOLUME "G" PAGE 89 FOR A GENERAL TREATMENT OF "DIAGRAMMING"	



FOUR DIRECTIONS IN WHICH A FORCE CAN BE APPLIED TO OBJECTS

CONCEPTS	A force to the RIGHT	A force to the LEFT	An UPWARD force	A DOWNWARD force
Examples				
Definition	Pushing to the right from the left of the cart	Pushing to the left from the right of the cart	Pushing upward from below the box	Pushing downward from above the box
DEFINING PROPERTIES	A force, either a push or a pull, applied in a RIGHT-HAND direction	A force, either a push or a pull, applied in a LEFT-HAND direction	A force, either a push or a pull, applied in an UPWARD direction	A force, either a push or a pull, pplied in a DOWNWARD direction
POSSIBLE VARIATIONS	The force can be applied: ··From the left-hand side of the object (as a PUSH toward the RIGHT) OR ··From the right-hand side (as a PULL toward the RIGHT)	The force can be applied: ··From the right-hand side of the object (as a PUSH toward the LEFT) OR ··From the left-hand side (as a PULL toward the LEFT)	The force can be applied: ··From below the object (as a push UP) OR ··From above (as a pull UP)	The force can be applied: ··From above the object (as a push DOWN) OR ··From below (as a pull DOWN)
EXAMPLE	Pulling to the right from the right of the cart	Pulling to the left from the left of the cart	Lifting or pulling upward from above the box	Pulling downward from below the box

⑥ Do the exercises on the next page.

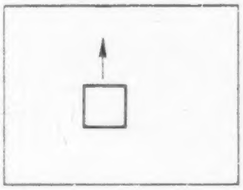
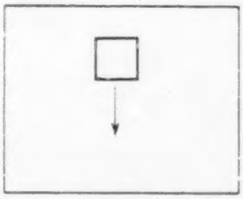
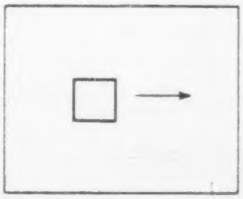
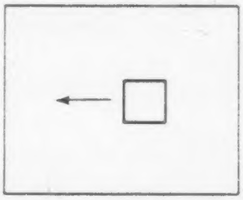
NOTES:
1. *The concept or class label appears at the top of the diagrams.*
2. *Everyday familiar example(s) appear in the top row (each cell should ideally have two or more examples).*
3. *The relevant properties, which examples belonging to the class must have, appear in the second row.*
4. *Irrelevant properties, which examples belonging to the class may have, appear in the third row.*
5. *The bottom row may be used for miscellaneous reasons: additional examples, applications, explanations, etc.*
6. *Instruction to learner to do exercise problems based on the diagram.*

A. RECOGNIZE and EDIT

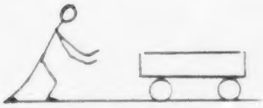
AFTER READING THE DIAGRAM, YOU MAY REFER TO IT WHILE DOING THE FOLLOWING PROBLEMS.

A.1 On which side of the objects are the following forces being applied?

A.2 In which direction are the forces being applied?

	above	below	right	left	upward	down-ward	to the right	to the left
	X				X			
		X				X		
			X				X	
				X				X

A.3



Correct this statement if it's wrong:

"The force was applied on the left in a left-hand direction."

Was applied in a right-hand direction.

Continued

B. PRODUCE

DO NOT REFER TO THE DIAGRAM WHILE DOING THESE PROBLEMS.

B.1 What are some of the directions in which a force can be applied to an object?

Up, down, right, left

B.2 When the sergeant tells recruits to carry their own bags, what kind of force is he telling them to apply to the bags?

A force applied in an upward direction

B.3 Cite two different ways you might apply a right-hand force to a table.

You can push it (from the left) or pull it (from the right)

B.4 When a sign instructs train passengers to pull the emergency cord, what is it instructing passengers to do?

To apply a downward force to it

B.5 What do we mean by the direction of a force? Give two contrasting examples different from the ones used here.

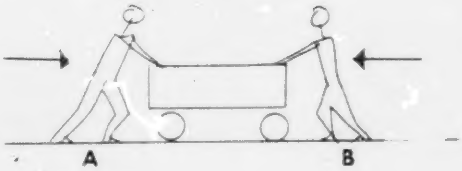
Whether a push or a pull applied to the object is toward the right, left, up, or down

THE END

ILLUSTRATIVE SEQUENCE

	page
(7) A sequence illustrating a shaping sequence	106

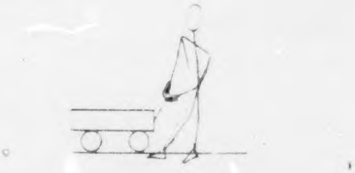
1.



Man B is applying a pushing force to the cart in a left-hand direction.

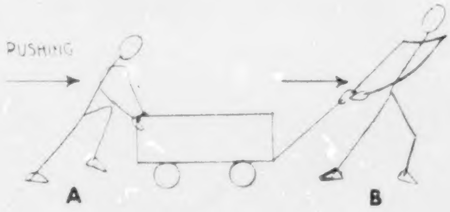
Man A is applying a pushing force to the cart in a *right-hand direction*.

2.



The man is applying a pulling force to the cart in a *right-hand direction*.

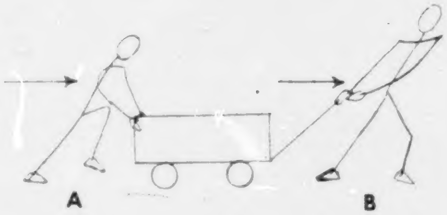
3.



Man A is applying a *pushing* force to the cart in a *right-hand direction*.

Man B is *applying* a *pulling* force to the cart in a *right-hand direction*.

4.

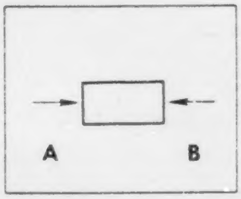


Man A is on the left side of the cart.

Man B is on the *right* side of the cart.

Both men are applying *a force to the cart in a right-hand direction*.

5.



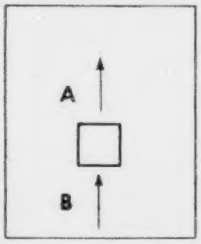
Arrow A represents a force being applied to the box in a right-hand direction.

Arrow B represents *a force being applied to the box in a left-hand direction*.

Arrow B is being applied to the *right* side of the box.

Continued

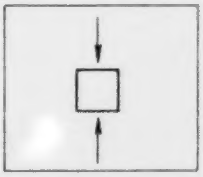
6.



Arrow B represents an upward force being applied to the bottom of a box.

Arrow A represents an upward force being applied to the top of the same box.

7.



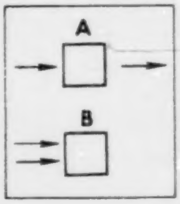
What kind of force is being applied to the top of the box?

A force in a downward direction

What kind of force is being applied to the bottom of the box?

A force in an upward direction

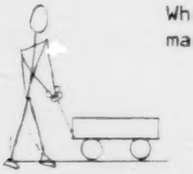
8.



What is the difference between what is illustrated in A and B?

In B, two forces are being applied in a right-hand direction, from the left side of the box. In A, the two right-hand forces are being applied on different sides of the box.

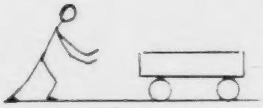
9.



What is this man doing?

Applying a force to the cart in a left-hand direction

10.



What has this man just done?

Applied a right-hand force to the cart

Continued

11. What are some of the directions in which a force can be applied to an object?

Up, down, right, left

12. When the sergeant tells recruits to carry their own bags, what kind of force is he telling them to apply to the bags?

A force applied in an upward direction.

13. Cite two different ways you might apply a right-hand force to a table.

You can push it (from the left) or pull it (from the right)

14. When a sign instructs train passengers to pull the emergency cord, what is it instructing passengers to do?

To apply a downward force to it

15. What do we mean by the direction of a force? Give two contrasting examples different from the ones used here.

Whether a push or a pull applied to the object is toward the right, left, up, or down

THE END

END OF
BACKGROUND INFORMATION

JOB PROCEDURES

	page
Information sources to review	110
Determining how to prepare instructional sequences	111
SUMMARY OF PROCEDURES	112
Adequacy of preparation of instructional materials	113
FORM I.2(1): DEVELOPING INSTRUCTIONAL MATERIALS	115, 116

I.2.1

IDENTIFICATION MATRIX

	SOURCES OF INFORMATION TO REVIEW AND WHAT TO LOOK FOR		
SOURCES OF INFORMATION	FORM G.1(2)	FORM A.5(4) or (11)	FORM D.2(1) + FORM D.2(2) + OUTPUT OF Sub-STEPS: I.1.1 I.1.2
CRITERIA	*From: FORM G.1(2)* *-Part IB* *··Criterion practice problem* *or* *··Description of criterion behavior* *-Part IIB* *··Preparatory practice progressions* *-Part III* *··Plans for behavior control* *-Part IV* *··Media decisions*	*From: FORM A.5(4) or (11)* *-Content of task analysis* *··Identification of:* */INPUTS* */ACTIONS* */OUTPUTS*	*From: FORM D.2(1)* *-Statement of criterion objective* *-Statement of preparatory objective* *··Modified* *··Unmodified* *From: OUTPUT OF Sub-STEP I.1.1* *-Decision about how much to practice:* *··Component skills* *··Whole sub-STEP* *··Combination of Sub-STEPS* *From: OUTPUT OF Sub-STEP I.1.2* *-Decision of order of practice of above* *From: FORM D.2(2)* *-Statement of objectives for students*

I.2.1

DECISION MATRIX

DETERMINING HOW TO PREPARE INSTRUCTIONAL SEQUENCES APPROPRIATE TO THE SUB-CRITERION BEHAVIOR AT HAND

<table>
<tr><td>CONDITIONS</td><td>Sub-Criterion Behavior
A</td><td>Sub-Criterion Behavior
B</td><td>Sub-Criterion Behavior
C</td></tr>
<tr><td>ACTION TO TAKE</td><td colspan="3"><i>Prepare an instructional sequence for each sub-criterion behavior that reflects:</i>
<i>-The content of the sub-criterion behavior as identified in task analysis diagram [FORM A.5(4)], statement of objectives [FORM D.2(1)], and progressions selected [FORM G.1(2)]</i>
<i>-The progressions selected and recorded on FORM G.1(2)</i>
<i>-How much of the sub-criterion behavior to practice at the same time (OUTPUT of Sub-STEP I.1.1</i>
<i>-The order parts of sub-criterion behavior should be practiced in (OUTPUT of Sub-STEP I.1.2)</i>
<i>-Plans for behavior control as identified in: decisions made in Sub-STEP G.3.1; and statement of objectives for students [FORM D.2(2)]</i></td></tr>
</table>

I.2.1

ILLUSTRATION SUMMARIZING PROCEDURES INVOLVED IN PREPARING INSTRUCTIONAL SEQUENCES

#1

REVIEW

a. All task analysis FORMS A.5(4) or (11) associated with the sub-criterion behavior

b. Strategy FORM G.1(2)

c. Statement of objectives: FORM D.2(1), FORM D.2(2)

d. Decisions made in Sub-STEPS: I.1.1 and I.1.2

#2

IDENTIFY

a. Content of the sub-criterion behavior (type of INPUTS, ACTIONS, and OUTPUTS)

b. Progressions to be used

c. Plans for behavior control

d. Media to be used

e. Decisions about how much and order of practice of sub-criterion behavior

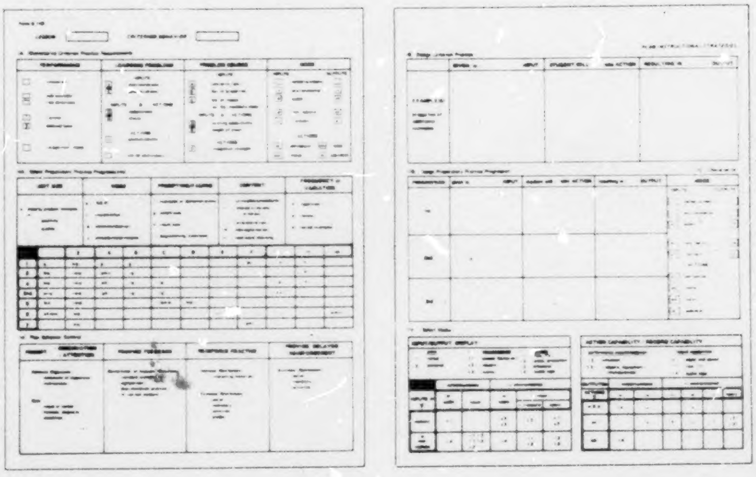
#3

DEVELOP

a. An instructional sequence reflecting what was identified in #2

b. (Where applicable), use FORM I.2(1)

FORM G.1(2)



FORM I.2(1)

I.2.1
STANDARDS
MATRIX

ASSESSING THE ADEQUACY OF PROCESS OF PREPARING INSTRUCTIONAL SEQUENCES

PROPERTIES	RELEVANCE	COMPLETENESS	LEANNESS
CRITERIA	Instructional sequence is based on previous Sub-STEP: -Content identified -Strategies selected: ··Progressions ··Behavior control ··Media -Order and amount of sub-criterion behavior practiced	Instructional sequence contains: -Statement of objectives for students -Behavior control features: ··Instructions ··Attention controlling features ··Active practice ··Feedback -Practice which meets all the learning problems involved in the sub-criterion behavior: ··Component skills not already learned are practiced -Features to make practice reinforcing: ··Interesting materials when possible	The instructional sequence is prepared lean in the interest of: ··Efficiency ··Stretching the student ··Providing a systematic basis for revising the sequence

Form I.2(1)

LESSON ☐ *(SUB-) CRITERION BEHAVIOR* ☐

	MAXIMUM ASSISTANCE	INTERMEDIATE ASSISTANCE	NO ASSISTANCE
RECOGNIZE			
EDIT			
PRODUCE			

Form I.2(1)

LESSON ☐ *(SUB-) CRITERION BEHAVIOR* ☐

	MAXIMUM ASSISTANCE	**INTERMEDIATE ASSISTANCE**	**NO ASSISTANCE**
RECOGNIZE			
EDIT			
PRODUCE			

Form I.2(1)

LESSON ☐ (SUB-) CRITERION BEHAVIOR ☐

	MAXIMUM ASSISTANCE	INTERMEDIATE ASSISTANCE	NO ASSISTANCE
RECOGNIZE			
EDIT			
PRODUCE			

PREVIEW OF THE NEXT SubSTEP

YOUR PRODUCT	*Instructional materials which teach the entire criterion behavior.*
WHAT YOU WILL WORK FROM	(1) Instructional materials for each sub-criterion behavior. (2) Prior decisions about the order of practice.
WHAT YOU WILL DO	(1) Decide about the number of sub-criterion behaviors to be practiced together (2) Decide about the order in which sub-criterion behaviors will be practiced. (3) Program instructional materials linking sub-criterion behaviors thereby teaching the entire criterion behavior.
FORMS YOU WILL USE	None

DESCRIPTION OF Sub-STEP	I.2.2

INPUT		ACTION		OUTPUT
An instructional sequence for each sub-criterion behavior + Previous decisions about order of practice iv	→	Prepare instructional sequence to chain all sub-criterion behaviors v	→	An instructional sequence to chain all sub-criterion behaviors leading to performance of the CRITERION behavior vi

Job Aid Contents

CRITERIA FOR IDENTIFYING INPUTS	ACTION TO BE TAKEN	STANDARD FOR OUTPUTS	FORMS TO USE
-MATRIX: Problems in chaining all sub-criterion behaviors . . . 119 -MATRIX: Information needed and sources 132	-MATRIX: How many sub-criterion behaviors to treat at same time and order. 133	-MATRIX: Adequacy of sequence for chaining sub-criterion behaviors . . . 135	SUMMARY OF PROCEDURES . . 134

Required Materials

COMPLETED MATERIALS	STEP	COMPLETED FORMS	STEP	BLANK FORMS
Instructional sequences for all sub-criterion behaviors	I.2.1	FORM I.2(1) (where appropriate)	I.2.1	
		Collection of forms (carried forward)	I.2.1	

Sub- **STEP** I.2.2

JOB DIAGRAM

INPUT	ACTION	OUTPUT
An instructional sequence for each sub-criterion behavior + Previous decisions about order of practice iv	Prepare instructional sequence to chain all sub-criterion behaviors v	An instructional sequence to chain all sub-criterion behaviors leading to performance of the CRITERION behavior vi
-Many sub-criterion behaviors + -Sub-criterion behaviors are: ··Longer ··More complex ··More difficult iv.a	-Deal with a smaller number of sub-criterion behaviors at the same time -Consider a backward order v.a	Instructional sequence chaining the sub-criterion behaviors vi.a
-Few sub-criterion behaviors + -Sub-criterion behaviors are: ··Shorter ··Less complex ··Less difficult iv.b	-Deal with a larger number of sub-criterion behaviors at the same time -Consider a backward or forward order v.b	Instructional sequence chaining the sub-criterion behaviors vi.b

BACKGROUND INFORMATION

	page
Differences in ways to deal with sub-criterion behavior and criterion behavior	120, 121
Decisions about how much of and order of criterion behavior practice	122
How many sub-criterion behaviors should be linked at the same time	123
Order of linking sub-criterion behaviors	124
Illustrative sequence on chaining sub-criterion behaviors	125

I.2.2

IDENTIFICATION

MATRIX

DIFFERENCES BETWEEN INSTRUCTIONAL SEQUENCES DEVOTED TO SUB-CRITERION BEHAVIORS AND SEQUENCES DEVOTED TO CRITERION BEHAVIORS

TYPE OF BEHAVIOR DEALT WITH	SUB-CRITERION BEHAVIOR	CRITERION BEHAVIOR
CRITERIA	*-A sub-criterion behavior may consist of:* *••One Sub-STEP* *••Two or more Sub-STEPS* *-An instructional sequence devoted to a sub-criterion behavior may concentrate on any of the following:* *••Each component skill (within a Sub-STEP) treated separately* *••Component skills within a Sub-STEP treated in combination* *••A Sub-STEP treated as a whole and by itself* *••Two or more Sub-STEPS treated together (if the sub-criterion behavior consists of more than one Sub-STEP)*	*-A criterion behavior may consist of:* *••One sub-criterion behavior* *••Two or more sub-criterion behaviors* *-An instructional sequence devoted to a criterion behavior concentrates on:* *••Linking up or relating all the sub-criterion behaviors:* */All at the same time* */Piecemeal (by groups of sub-criterion behaviors)*

I.2.2

IDENTIFICATION
MATRIX

ESSENTIAL DIFFERENCE BETWEEN WHAT IS COVERED IN SUB-STEPS I.2.1 AND I.2.2

Sub-STEP	Covered in Sub-STEP I.2.1	Covered in Sub-STEP I.2.2
CRITERIA	*-Each sub-criterion behavior has not yet been learned* *-Sub-STEP I.2.1 provides for teaching procedures for developing sequences of each sub-criterion behavior* *-A succession of such sequences provides the practice necessary for the student to learn all the separate sub-criterion behaviors*	*-All the sub-criterion behaviors have now been learned* *-The learner must now acquire the chain that links the sub-criterion behaviors together*
EXAMPLES	#1 e.g., two sub-criterion BEHAVIORS (each one consisting of one Sub-STEP), each sub-criterion behavior taught separately *-Concept "direction of force? is taught as a separate sub-criterion behavior* *-Concept "direction of movement" is taught as a separate sub-criterion behavior* #2 e.g., ONE SUB-CRITERION BEHAVIOR (consisting of TWO Sub-STEPS taught in combination) *-The two concepts (above) are treated together as one sub-criterion behavior*	e.g., two sub-criterion behaviors are chained to make up a criterion behavior *-In Example #1 to the left, two sub-criterion behaviors were treated separately because it was judged that this was required* *-Now they must be linked and interrelated* NOTE: This linking process involves a different set of procedures than those used in Example #2. In Example #2, the two were treated together because it was assumed that the two concepts were not posing so difficult a learning problem as to require separate treatment

I.2.2

IDENTIFICATION
MATRIX

TWO DECISIONS THAT HAVE TO BE MADE ABOUT PRACTICE OF CRITERION BEHAVIOR

TWO DECISIONS	HOW MUCH of criterion behavior should be practiced at the same time	ORDER of practice of parts of criterion behavior
CRITERIA	*-How many sub-criterion behaviors can be chained or linked together --at the same time* *••Two at a time* *••Three or more at a time*	*-In what order should each of the sub-criterion behaviors (relative to other sub-criterion behaviors) be given its separate treatment (Decision made in Sub-STEP I.1.2)* *-In what order should the sub-criterion behaviors (in sets of two or more) be chained or linked together (Decision to be made in this Sub-STEP, I.2.2)*
EXAMPLES	e.g., see page 74 re: concepts of force and motion *-Should the concepts (force, direction of force, strength of force, movement, direction of movement, and balanced/unbalanced forces) all treated as sub-criterion behaviors be chained:* *••In pairs* *••In sets of three or more sub-criterion behaviors*	e.g., see page 74 re: concepts of force and motion *-In what order should the sub-criterion behaviors (See the left-hand column) be taught?* *-In what order should the sub-criterion behaviors be chained or linked?*

I.2.2

DECISION MATRIX

DETERMINING HOW MANY SUB-CRITERION BEHAVIORS SHOULD BE LINKED AT THE SAME TIME

<table>
<tr><td>CONDITIONS</td><td>The larger, more complex, or more inclusive
the sub-criterion behaviors involved in criterion behavior</td><td>The smaller, less complex, or less inclusive
the sub-criterion behaviors involved in criterion behavior</td></tr>
<tr><td>ACTION TO TAKE</td><td><i>-Group fewer numbers of sub-criterion behaviors for practice together</i>
<i>HOWEVER</i>
<i>-Attempt to group as many as is deemed feasible (i.e., learners can handle effectively)</i>
<i>AND</i>
<i>-Use cuing techniques to facilitate larger groupings, e.g., diagramming</i></td><td><i>-Group larger numbers of sub-criterion behaviors for practice together</i>
<i>AND</i>
<i>-Attempt to group as many as is deemed feasible (i.e., learners can handle effectively)</i>
<i>AND</i>
<i>-Use cuing techniques to facilitate larger groupings, e.g., diagramming</i></td></tr>
<tr><td rowspan="3">EXAMPLES</td><td>e.g., smaller number of sub-criterion behaviors to be linked at the same time</td><td>e.g., larger number of sub-criterion behaviors to be linked at the same time</td></tr>
<tr><td colspan="2">Sub-criterion behaviors include: (1) identifying the type of problem presented as one involving "current" and selecting Ohm's Law as the formula; (2) transferring problem numerical values into the formula; (3) doing the computations; (4) taking obtained values and using them in selecting resistors offering appropriate resistance.</td></tr>
<tr><td><i>-Pairs of two sub-criterion behaviors are linked together at the same time</i></td><td><i>-All four sub-criterion behaviors can be linked at the same time</i></td></tr>
</table>

I.2.2 DECISION MATRIX	DETERMINING THE ORDER IN WHICH SUB-CRITERION BEHAVIORS ARE TO BE CHAINED	
CONDITIONS	Prior decision in Sub-STEP I.1.2 for a FORWARD order of dealing with Sub-STEPS	Prior decision in Sub-STEP I.1.2 for a BACKWARD order of dealing with Sub-STEPS
ACTION TO TAKE	*-Still consider a backward order for chaining of sub-criterion behaviors* *-The more sub-criterion behaviors there are (and, therefore, the more difficult the learning of the chain), the more effective a backward order may be*	*-Develop a sequence in which the sub-criterion behaviors are linked or chained in a backward order*

ILLUSTRATIVE SEQUENCE

	page
Chaining the concepts involved in the examples used in Sub-STEP I.2.1	126

*

The instructional sequence that follows illustrates how two separately and previously taught "KNOWLEDGE DOMAIN" sub-criterion behaviors (one involving the concept of "direction of force," the other involving the concept "direction of movement") are now chained together.

In general, techniques used for chaining Sub-STEPS [See "progressions" suitable for chaining identified in Part IIA of FORM G.2(2)] are appropriate for chaining the two sub-criterion behaviors (or any number of sub-criterion behaviors).

Chaining Two Sub-Criterion Behaviors

1. The direction of a force applied to an object and the direction the object moves are always the same.

   If a man applies an upward force to a briefcase, the briefcase will *move in an upward direction*.

2. What will happen to an automobile when the wind hits its side with a force applied in a right-hand direction?

   It will move (sway) to the right

3. In order to get a stalled automobile moving in reverse, what must a group of men do?

   Apply a force to the car in the reverse direction

4. What determines the direction of movement of any object? Give an example.

   The direction of the force applied to it

   Any example in which the direction of force and the direction of movement are the same

THE END

*

The instructional sequence that follows illustrates how "PERFORMANCE" sub-criterion behaviors, each of which has already been previously learned, are now simply chained together so that the learner can now perform them all in the correct order (thereby exhibiting the CRITERION BEHAVIOR).

Sub-Criterion Behavior #1	Identifying the type of statistic required to analyze a set of data
Sub-Criterion Behavior #2	Applying the statistic to the data collected
Sub-Criterion Behavior #3	Identifying the significance of the statistical test
Sub-Criterion Behavior #4	Interpreting the results

The CRITERION behavior involves this entire series of behaviors.

Chaining Sub-Criterion Behaviors in a "PERFORMANCE" Area

1. The hypothesis is that there will be a significantly larger score after administration of an experimental treatment.

Given the following distribution of scores on a test:

Before	After
32	15
41	29
16	14
17	32
19	58
32	42
⋮	⋮
X_A	X_B

Perform the following steps:

- ••Select the appropriate statistic to test the hypothesis
- ••Compute that statistic
- ••Determine the statistical significance of the result
- ••Determine whether the hypothesis has been rejected.

ANSWER

-*A t test for difference scores could be used.*

-*A one-tailed test should be used (since the direction of the hypothesis was specified).*

-*(The answer and the interpretation would be given the student.)*

Continued

Chaining Sub-Criterion Behaviors in a "PERFORMANCE" Area (Continued)

2. Test the hypothesis that Group A and Group B do not differ. Here are the scores obtained for each group:

A	B
19	05
19	29
22	32
14	04
39	09
⋮	⋮
X_A	X_B

ANSWER

-A t test for unrelated scores should have been used.

-A two-tailed test should have been performed since the direction of the difference was not specified.

-(The answer and the interpretation would be given the student.)

3. Additional problems, each representing either the same or different types of "testing" situations, would be provided.

NOTE the difference between Items #1 and #2: #1 is guided; #2 is not.

JOB PROCEDURES

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Information to obtain and sources for it	132
Determining how many sub-criterion behaviors (and their order) to treat at the same time	133
SUMMARY OF PROCEDURES	134
Adequacy of the sequence for chaining of all the sub-criterion behaviors	135

I.2.2 IDENTIFICATION MATRIX	INFORMATION SOURCES TO REVIEW AND TYPES OF INFORMATION TO IDENTIFY		
INFORMATION SOURCES	OUTPUT of Sub-STEP I.2.1	FORM G.2(1) (Part IIB - Progressions) + OUTPUT of Sub-STEP I.1.1	OUTPUT of Sub-STEP I.1.2
CRITERIA	*-Identification of the number of sub-criterion behaviors comprising the criterion behavior*	*-Decisions about forward or backward chaining*	*-Identification of the size or scope of each sub-criterion behavior*

I.2.2

DECISION MATRIX

DETERMINING HOW MANY SUB-CRITERION BEHAVIORS TO CHAIN AT THE SAME TIME AND THEIR ORDER

CONDITIONS	-There are many sub-criterion behaviors involved in the criterion behavior + -The sub-criterion behaviors are (one or more of the following): ··Longer ··More complex ··More difficult (i.e., even though already learned, proficiency may be marginal*)	-There are few sub-criterion behaviors involved in the criterion behavior + -The sub-criterion behaviors are (one or more of the following) ··Shorter (fewer Sub-STEPS) ··Less complex ··Less difficult
ACTION TO TAKE	*-Deal with a smaller number of sub-criterion behaviors at the same time:* *··Two or three at the same time* *-Consider backward chaining (even if not previously considered)*	*-Deal with a larger number of sub-criterion behaviors at the same time:* *··Three, four, or more at the same time* *-Consider either forward or backward chaining*

*Marginal proficiency can be defined as: (a) performance being more subject to forgetting; or (b) requiring more aids or cues.

I.2.2

ILLUSTRATION SUMMARIZING PROCEDURES IN DEVELOPING PROCEDURES FOR CHAINING SUB-CRITERION BEHAVIORS

#1	#2	#3
REVIEW	IDENTIFY	DEVELOP
a. Output of Sub-STEP: I.1.2	a. Size and/or scope of each sub-criterion behavior	a. An instructional sequence to chain the sub-criterion behaviors
b. Output of Sub-STEP: I.2.1	b. Number of sub-criterion behaviors comprising the criterion behavior	
c.1 Part IIB of FORM G.2(1)	c. Decisions about forward or backward chaining	
c.2 Output of Sub-STEP: I.1.1		

I.2.2

STANDARDS

MATRIX

CRITERIA FOR ASSESSING ADEQUACY OF PROCEDURES FOR INSTRUCTIONAL SEQUENCES DESIGNED TO CHAIN SUB-CRITERION BEHAVIORS

PROPERTIES	RELEVANCE	COMPLETENESS	LEANNESS
CRITERIA	*-The instructional sequence chains sub-criterion behaviors in groups of two or more based on an identification of:* *••The number of sub-criterion behaviors* *••Their length* *••Their complexity* *••Their difficulty*	*-All the sub-criterion behaviors are chained to provide an instructional sequence that provides practice in the CRITERION behavior*	*-The instructional sequence is as lean as it can be made*

STEP I.2

COMPLETION CHECKLIST

	IDENTIFIED	PERFORMED	PRODUCED	FORMS COMPLETED
I.2.1			An instructional sequence for each sub-criterion behavior	FORM I.2(1) (where applicable)
I.2.2			An instructional sequence chaining all the sub-criterion behaviors	